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FARMING SYSTEMS RESEARCH METHODOLOGY TRAINING COURSE

RESOURCE MANUAL

(Volume I & II)

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VOLUME II

PREFACE

Farming Systems Research Methodology training course Resource Manual is based on the contribution of 36 resource persons from 15 institutions. The 'Volume I' of the manual consists of Farming Systems Research Concept, FSR in Bangladesh perspective, general considerations of diagnosis and design on FSR methodology. The 'Volume II' consists of description on crop subsystem, livestock subsystem, homestead subsystem, agroforestry subsystem, fisheries subsystem, agribusiness, gender issues; testing and evaluation and dissemination of FSR Technology.

The training was organized by National Coordinated Farming Systems Research Program of BARC at Bangladesh Agricultural Research Institute Joydebpur. The participants were from 10 institutions of National Agricultural Research Systems. The curriculum was prepared on the basis of need assessment of FSR Scientists. Scientific Officer, Senior Scientific Officer and Principal Scientific Officers of National Agricultural Research System were the main participants. Most of the NARS FSR Senior Scientists and Expatriate Scientists concerned with FSR participated as resource persons. IRRI and FSRD/E training resource manuals served as guideline to develop such location specific need based resource manual. We hope this compiled resource manual will serve as guideline for sustainable FSRD in Bangladesh.

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CONCEPTS OF FARMING SYSTEMS : FARM COMPONENTS OF FARM AND FARMING SYSTEMS.

Dr. M. H. Khan

Introduction

Research in agriculture aims ultimately at improving the production practices for increasing the productivity of a farm. Farming Systems Research has proved itself in the recent past to be a very useful and important approach in understanding and identifying farming problems, and designing and testing appropriate technologies at the farm level. The overall goal has been to raise the farm productivity while relying on the existing resources and facilities available to the farmers. Though the farming systems approach to research is relatively a recent development, farming systems existed there when farming began in the pre-historic time. So, today's farming system may be called the metamorphic form of the pre-historic one.

In this handout, attempt has been made to define and understand 'Farm' 'System', Farming System and its components in the context of the FSR methodology.

Farm and Farming Systems

Literally the word 'farm' means a piece of land cultivated by its owner or a tenant. But we the agriculturalists understand a little more. To us a farm means cultivable land, homestead used for housing the farmer, his family, farm animals and implements used for farming.

A system similarly means an assemblage of things forming a regularly connected functional unit. Thus a farming system literally is a functional unit which comprise of certain sub-units we call components/elements sub-systems/enterprises. Beyond the literal meaning farming systems mean a unique and reasonably stable arrangement of farming enterprises that the household manages according to well-defined practices in response to the physical, biological, and socio-economic environments and in accordance with the household's goals, preferences and resources. These factors combine to influence output and production methods. More commonality is found within the system than between systems. The farming system is a part of larger systems e.g., the local community and can be divided into sub-systems e.g., cropping systems.

"A farming system is not simply a collection of crops and animals to which one can apply this input or that an expect immediate results. Rather it is a complicated interwoven mesh of soils, plants, animals, implements, workers, other inputs and environmental influences with the strands held and manipulated by

a person called the farmer who, given his preferences and aspirations, attempts to produce output from the inputs and technology available to him. It is the farmer's unique understanding of his immediate environment, both natural and socio-economic, that results in his farming system."

Thus a farming system involves complex interaction between a variety of interdependent components both physical and psychical which, in turn, may often be viewable as subsystems. Central to the system is the farmer himself.

The environment is seen as having two elements : human and technical. The technical element, specified in terms of available technology and climate, defines production possibilities. The human element involves exogenous factors (including the socio-economic and cultural environment) that influence the farmer's decision making as to what farming system he will use in the face of the technical and resource constraints that he faces.

The enterprises are mainly crops, farm animals, homestead crops and agro-forestry, and fisheries. These farm enterprises are so inter-related that they give rise to more or less a stable system we call the farming system. This farming system is managed and operated by the farmer to the best of his knowledge and ability under the existing socio-economical, physical and biological environments. The farming systems practiced by the farmers have been developed over time through experiences, to suit best to the farmers' needs, goals, aspirations and the resource they can invest. Thus, farming system is defined as a reasonably stable arrangement of farming enterprises that the farmer manages according to well-defined practices in response to the physical, biological and environments and in accordance with his goals, preferences and resources.

Farming Systems in Bangladesh and other South Asian Countries

The climatic and edaphic situations in Bangladesh, unlike other countries of the temperate region, allow farmers to grow a variety of crops in a field more than one time a year. The growing of these multiple crops is supported in general by other farm enterprises in one way or the other. Thus, farming system in this region is crop dominated and other enterprises are usually supportive to the production of crops. But that does not undermine the importance of non-crop enterprises so far as the functioning of the total farming systems is concerned.

An average farm in Bangladesh and their neighbouring countries does not grow only crops or raise animals. Here usually the cattle provide draft power and manure for crop production and milk, meat and hide for cash income. Similarly the poultry and goat utilize the crop by-products and provide cash and food to the farmers. The homestead area contributes to the farm productivity by producing vegetables, spices, timber,

fuel wood etc. and providing a work space for processing and storing crops and crop by-products. Some farm families have access to small ponds which may be used for raising fish and ducks simultaneously. The common farming systems are thus multi-enterprise based rather than single enterprise based.

An analogy of a system and components may be drawn with a motor vehicle. The efficiency of a motor vehicle depends on the functioning of the component systems like cooling system, transmission system, electrical system, fuel system and so on. Improvement in one of the system is unlikely to improve the efficiency of the vehicle as a whole unless all other systems are improved at the same level. The driver of the vehicle may be compared to the farmer.

Components of Farming Systems

A farming systems includes all the activities performed on a farm to fulfill the needs and objectives of the farm family. Therefore, farming systems research must critically assess why and how farmers allocate their resources, including family labour and purchased inputs, to the different on-farm and off-farm activities. An effort must be made to understand the seasonality of input requirements for each farming enterprise or component and to understand how external factors influence the farmers in making certain decision.

Crop Component

Research within the crop subsystem concentrates on improving the yield of individual crops and cumulative production of crops round the year on a given farm. Attention is given to management practices, the interactions among crops and the interaction between crops and other enterprises.

As with other elements of the farming systems, yield improvement strategies in the crop subsystem are based on modifications of existing farming practices for crop management and crop rotation which have been developed and selected by the farmers themselves over time. The existing cropping patterns reflect the way the farmers allocate their land, labour and capital resources in crop production to meet their objectives and kinds of return they expect from those resources. Alternative (experimental) cropping patterns should first be discussed with farmers. Then field testing should monitor the differences in the performance of the experimental cropping patterns compared to the performance of the farmer's existing patterns. Since there are residual effects of fertilizers on crops in a rotation pattern, it is important to design fertilizer recommendations for an entire cropping pattern rather than for individual crops in that pattern.

Generally, land under cultivation is divided into several parcels which are separated, and located at varying distances from the homestead. In order to evaluate the ability of farmers to fully utilize the different cropping patterns being tested, attempts must be made through on farm trials to incorporate all the plots belonging to the selected farmers. In this way limitations in the resource endowment necessary to adopt such technology are evident at early stages of the technology screening process.

Livestock Component

The livestock subsystem is a second major component of farming systems in Bangladesh, providing draft power, food, hides, wool, manure for fuel and fertilizer, income and social status. However, due to the mobility of animals, their longer life span than crops and their multiple outputs, research approaches with livestock are much different from those employed in the crop subsystem. For example, in a given on-farm experiment, not all animal units will be of the same age and in the same condition of health. Often animals herds or flocks are of mixed breeds. It is often hard to place an economic value on such inputs as grazing materials. Much larger experimental units than the small plots used in crops, are required. This means that the cost of research is often greater for an experiment with livestock than it is with crops.

Also, expertise in livestock experimentation is often inadequate at FSR sites. Since it is difficult to control non-experimental variables in the diet and health of animals, it is hard to isolates treatment effects in experiments, resulting in experimental data with high coefficients of variation. Nevertheless, on-farm experimentation is necessary, because conditions on research stations do not reflect the production environments found on most farms. In fact, the recommendation domains derived for livestock, may differ significantly from those derived for crops.

It is not difficult to understand why most FSR programmes have a distinct bias towards the crop subsystem which is more accessible and important in the short-term. Crop research is cheaper and it is relatively easy to detect the labour utilization pattern for crops. Most ventures into the realm of the livestock subsystem actually begin with looking at the utilization of crop by-products, such as rice straw for fodder. However, inspite of the fact that monitoring livestock is a complex and long-term proposition, a holistic FSR programme demands an emphatic attention to the livestock subsystem.

Given the scarcity of livestock feed in Bangladesh, studies on animal nutrition merit priority, particularly in relation to the critical period for reproduction and lactation. Low fertility levels and high mortality rates of most livestock are directly related to inadequate animal nutrition. Draft equipment (e.g. yokes for single hitch animals) is a logical area of FSR intervention in cows and bullocks and the effect of workload on draft animals' nutritional requirements, particularly for lactating cows, requires investigation. In addition, factors contributing to animal health cannot be overlooked.

Agroforestry Component

Most forestry improvement projects in Bangladesh concern production on forest reserves. However, approximately 70% of the timber and building materials and 90% of the fuel wood and bamboo come from the rural homestead. Some tree species, such as mango and jackfruit are multipurpose, producing fruit and timber, and the twigs and dried leaves of all trees are used as fuel for cooking. The young shoots and bark of the drumstick tree are often eaten as a vegetable, while the leaves of jackfruit trees are fed to goats and sheep. Fruit, timber and seedlings are also sources of cash income for the farm family.

Just as with the livestock subsystem, the long lifespan of trees and their multiple uses complicate FSR in agroforestry. Initial studies usually focus on the introduction of new fast-growing species. More recently, attention has been given to improving the productivity of trees through fertilization of micronutrients and the use of plant growth hormones, particularly in the case of mango trees, to prevent flower drop and fruit splitting. Attention has also been given to pest control and pruning management.

As the process of land fragmentation continues, the general trend is toward an increase in the number of homesteads each year. This means that nursery facilities and nursery management techniques are also potential areas of FSR intervention. Survey information suggest that there is a difference in species composition and forestry management on landless and landed farms with larger land holdings. Shade trees are detrimental to vegetable production on the homesteads with limited land areas. This suggests the need for class specificity in approaches to agro-forestry.

Homestead Component

Poultry, ducks, vegetables, species and trees are all produced in different combinations on the homesteads, and both cattle and goats are housed there in such a way as to allow the collection of dung. The role of women, who make up about 50% of the labour resources of the country, is particularly important in

homestead production. Most of the post harvest operations of threshing, drying and food and fodder storage take place on the homestead, and it is here that many of the most interesting interactions in farming systems research occur.

Trees are used as living fences around the homestead for privacy and for the protection of vegetable gardens. manure from farm animals is packed on to jute sticks and dried in the homestead for fuel. Irrigation on the vegetable beds helps in tree growth during the dry season. Tree leaves and sometimes water hyacinth from ponds and ditches are used as a mulch for conserving soil moisture in vegetable seedbeds, and many of the vitamins in family nutrition come from fruits and vegetables produced on the homestead. The homestead functions as the nucleus of the farm unit, and as such it is the point at which all other disciplinary components intersect.

Fisheries Component

Unlike the other subsystems discussed thus far, the fisheries subsystem is location specific any may not be present on all farms. However, where ponds or ditches are present, this component of the farming systems can be a valuable source of protein for family nutrition. At present, there are approximately 2 million ponds, tanks, beels, haors, and artificial reservoirs in Bangladesh. Where such facilities exist, attention should be given to improving fish production by applying the problem solving technologies of FSR.

Special attention must be given to the interaction of fish production with other farm activities, such as irrigation, rice cultivation, duck rearing, and recycling crop and animal by-products. Unlike the livestock subsystem, improved fish culture techniques often begin with the use of introduced species and careful control of fish populations. Also, nutrition is sometimes a limiting factor to higher fish production. Several studies have been conducted on the use of cowdung and crop by-products as fish feed in ponds.

The need for investigating into the farming systems

It is believed that the potential of farm productivity is manifold over the existing level and there are several reasons for the present low level productivity. One of these is the inefficient utilization of the available farm resources which, it is believed, could increase the farm income if properly exploited even under the existing socio-economic and agro-climatic conditions.

So to harness the potential of farm productivity, attention was given to develop the technology addressing the crop commodity which dominates over all other farming components and accounts for more than three fourths of the total farm income in the farming systems. Conventional discipline based technology so developed though proves itself excellent on station and even in farmer's fields, seldom gets accepted by the farmers. This is because the technology while being developed did not take into account the farmer's situations on the existing farming systems where it is designed to be accommodated. There are many such technologies which have been partially accepted or totally rejected by the farmers. The best example of commodity-oriented and single enterprise based technologies and the reaction of farmers to them is the introduction of HYVs of rice in 60s and their low level adoption.

Scientists have began to realize the importance to system oriented research and diverted their efforts to develop technologies suitable for a system followed by the farmers. Once again the CSR received the priority and crop production as a system approach received attention of the agricultural scientists in early 1970s with the participation of the farmers. The results and experience gained from the cropping systems research have led to the realization that increase in crop production through increased yield and cropping intensity beyound threshold limits, demand higher inputs in the form of draft power, capital, labour and other production inputs, some of which are possible to be met through improvement of non-crop farming components like livestock, poultry, fisheries, homestead gardening etc. Thus, a systematic approach to investigate into the farming system in its totality began.

The success of conventional commodity research depends on the degree of changes or adjustments it is designed to bring about in the whole system. If commodity research is designed to bring about a system revision, the probability of success is minimum. The failure of commodity research is usually because of misperception of the farmers' situation lack of understanding of the farmers' aspiration, desire, perception of risks and resource constraints. Systems research which necessitates a thorough understanding of the systems prior to the design of research aims to overcome before hand the difficulties mentioned above and ensure the probability of success of technologies so developed. The failure of commodity research, measured in terms of acceptability of the results by the farmers, is also due to the fact that commodity research -

a) usually overemphasizes the biological potential and yield considerations without sufficient consideration to other relevant criteria; and

b) sets priorities dictated by the government or others without involvement of the farmers and is carried out on farm in isolation of the farmers' conditions.

Although results of commodity or discipline oriented research have much less direct impact on increasing the efficiency of a system, their importance on systems research cannot be under estimated. Because the commodities make the systems. Results of commodity research are tested, verified and adjusted, if necessary, to give it a fit to the system. Thus commodity research and system research are complementary to each other.

Organizational problems of FSR

Compared to commodity research, systems research is complicated and a lengthy process. Because of multi-and inter-disciplinary in nature involving biological, social, economical and physical sciences organization of systems research team of scientists drawing from different institutions having different infrastructures and mandatory responsibilities, offers much difficulty. Also because of being a new research approach most scientists participating in the systems research in agriculture have developed their skill through experience and there exists a great deal of differences as to the concept, philosophy, principles and methodology of FSR. This is also because the scientists involved in the FSR have academic background in any one of the biological, social, economical or physical sciences. For obvious reasons and scientist of a particular discipline tends to get biased in his own discipline diluting sometimes the concept of systems research in its strict sense. However, through frequent meetings, seminars, symposia and other forums the differences in the concept of systems research are getting narrowed down. It is expected that in near future the Universities will be offering academic degrees in systems research in agriculture, when, hopefully, implementation of such approach of FSR in agriculture will be much easier.

SYSTEMS APPROACH DEVELOPMENT IN FARMING SYSTEMS RESEARCH AND ITS PROSPECT OF CONTRIBUTION TO RURAL DEVELOPMENT

R. N. Mallick

A system is any set of components or elements that are interrelated and interact among themselves. Two systems may share a common component or environment and one system may be a subsystem of another (TAC 1978). System research differs from traditional research in two major ways. The first difference lies in the way a problems is approached and analysed. The system based research has holistic approach, identifies gaps in the data base, so is efficient (Dillon 1976). By the mid 1970's serious doubts were being voiced about strict discipline oriented research being able to solve the small farmer's problems.

The farmer views his farm as a system and had a working knowledge of its interactions. With the rapid increase in farm population and the dwindling supply of new lands for cultivation, intensive cultivation has become an excellent strategy for absorbing excess farm labour. In intensive cropping the succession of crops is very rapid; that is, the interval between harvesting of one crop and planting of another is short and the management of one crop can significantly influence the performance of succeeding crops. Thus the traditional procedures for the generation and dissemination of technology, which concentrated on one crop at a time may not be adequate.

The objective of conventional discipline research is to increase the efficiency of a resource used for a given crop where as the objective of systems research is to increase the efficiency of systems as a whole. For example the best period for the planting of wheat is 15-30 November in Bangladesh but only about 40% of the wheat grower can plant wheat within that period due to several socio-economic constraints so the management of all the crops in the cropping pattern as a whole with the aim of maximizing productivity of the whole pattern in given piece of lands.

The concept of research based on a system approach is not new in agriculture. Roman farmers who used rotation copping seemed to grew richer. Rothamstead station has shown that rotation is superior to monocropping for the last 200 years. By the early 1900 research had started to move towards a disciplinary approach and by the early 1950 this approach firmly entrenched. By the 1970's, serious doubts were being voiced about strictly discipline oriented research being able to solve the small farmer's problems.

According to Brady (1977) the limited adoption by farmers to new production techniques reflects weakness in the ability of researchers to formulate production methods that compete favourably with the ones farmers already use.

The reductionist approach involved studying one or two factors at a time while attempting to control all others (Dillon, 1976). The FSR approach is, therefore, more realistic in orientation than the more conventional reductionist approach exemplified by commodity research programs.

Research on a sub-system can be considered part of the FSR process if the connections with other sub-stems are recognised and accounted for sub-system implies a boundary separating the system from its environment. Two systems may share a common component or environment and one system may be a sub-system of another. So a farm system can be broken down into a number of sub-systems for example, crops, livestock, and off-farm which may over lap and interact with each other (T AC 1978).

Downstream or site specific FSR programs are designed to rapidly identify and subsequently test possible innovations which can be easily integrated into existing farming systems.

Integrated means to make whole, to complete by addition of parts, or to combine parts into a whole. There is synergism in integrated farming since the working together of the sub-systems has a greater total effect than the sum of their individual effects. The main biological feature is by-product recycling. Small scale system should get focus as large number of population will get benefit.

A systems approach to any activity starts with the concept that everything is connected and change introduced in one part of the system will induce a change in other parts of the system. The study of parts of a system in isolation will not be adequate to understand the complete system or to solve problems that stand in the way. Modern concepts and techniques for a system approach were developed by military scientists out of a need to explore the total implications of alternative strategies to achieve specified goals.

A systems approach implies that there must be

- <u>A philosophical foundation</u> from which it derives (Popper 1959, checkland 1984).

- <u>A body of theory</u> upon which it rests (Boulding 1956, Bert-alanffy 1968; champbell, 1985).

- <u>A set of principles</u> to guide action, the first of which is to identify, classify and describe the systems in which one is interested in order to establish their initial state (Spedding 1979).

- A way of proceeding - The problem must be identified and clearly defined. (Einstein once said that the definition of the problem is more important than the solution).

A Systems approach evolves a way to bridge the gap between the generation of knowledge by research and the use of that knowledge to improve the output of products and money. To findout what is the purpose of farmer being "in the shoes of a farmer". The purpose of programs based on a systems approach is to produce people who are unafraid of either economist or getting hands dirty and are psychologists and diplomats.

A systems people knew a little bit about everything and not much about anything contrary to subject matter specialist who know more and more about less and less.

A systems approach provides an opportunity to know if one component is changed how is the effect on the system as a whole.

FSR approach is farmer based, problem solving, comprehensive interdisciplinary, complementary, interactive and dynamic, and socially responsible.

The basic approach of FSR is to devide a particular site is (i) Farming environment and (ii) Client group.

Component technology in farmer's fields was initiated in the late 1950s and system based research started in 1974. Besides growing crops, farmers raise cattle for draft and milk purposes and poultry for meat and eggs. Homestead is utilized for growing vegetable, shrubs, fruits as well as for post harvest processing.

System Approach Thrust

In 1983 GOB gave emphasis to a more comprehensive FSR approach and to include component. To begin with, the FSR thrust on site may be on only one component depending an priority. Farmers is considered as the central focal point. Crops contribute 36.8% to the GDP while livestock contribute 6.5%, fisheries 3.6% and forestry 3.1%. So crop system will dominate in FSR in Bangladesh.

The inter-relationships with other system components are important in system approved. The research mandates have caused to focus on improving production technology as the end.

Approach Development sees the farming famillities as a main actors, and attempts to put to use their vast unreflected knowledge of their situation.

Approach Development is a step-by-step method of how to find out to do practically when dealing with a concrete situation in the rural area.

The Farming Systems Approach FSR sites are meeting grounds for researchers, extension workers and farmers. The farmers problems are heard by the researchers and integrate their efforts and pool their resources.

Systems Theory

* Emphasized the need to view a situation as a whole and not as separate parts. The boundaries of systems change with change in focus.

* Recognizes interaction of components inside and outside the system in the process of transforming inputs to outputs.

* Stresses systems hierarchy whereby every system is part of a large system and itself consists of sub-systems.

The farm - household system is the principal system and focus of FSR. It consist of three basis sub-system.

1. Definition of a Systems

A system as an assemblage of elements in a boundary. Within the boundary elements are strongly linked to each other. Across the boundary links with elements in other systems are few, weak or non-existent. The strong link within the boundary produce a distinctive behavior. The system responds to many stimuli as a whole, even if a stimulus is only applied to one part of the system (Fig - 1)

2. Types of System

Physical - Planet, earth, solar system

Mechanical - Tractor, car.

Mechanical/living - Plough - oxen - man

Ecological - Pond, forest, grassland

Agro-ecological - Rice fields or Jute fields Cooperative Tar area.

Agro-ecological system - (Agricultural - Socio-economic - ecological system) is an ecological system partly modified by man to produce food, fibre or other agricultural product (Fig-2).

Features of an Agro-ecological system

1. Boundaries become sharper and stronger

   Ø Soil bund around field

   Ø Limited outside linkage for irrigation

2. Reduction innatural and biological components

Ø Only maize, weeds, and a few pests and diseases and their enemies

3. Ecological processes remain

Ø Competition between maize and weeds

Ø herbivary of maize by pests

Ø Predation of pesis by natural enemies.

4. But are modified by socio-economic processes

Ø Cultivation and harvesting of maize

Ø Subsidies in form of fertilizer

Ø Control of water and pests

Ø Cooperation and competition between people in management.

5. Agro-ecological system Hierarchies

Ø Systems higher in hierarchy tend to control those below

Ø Behaviour of systems higher up is not easily understood solely from study of systems lower down.

Ø Each level in hierarchy has to be studied in its own right.

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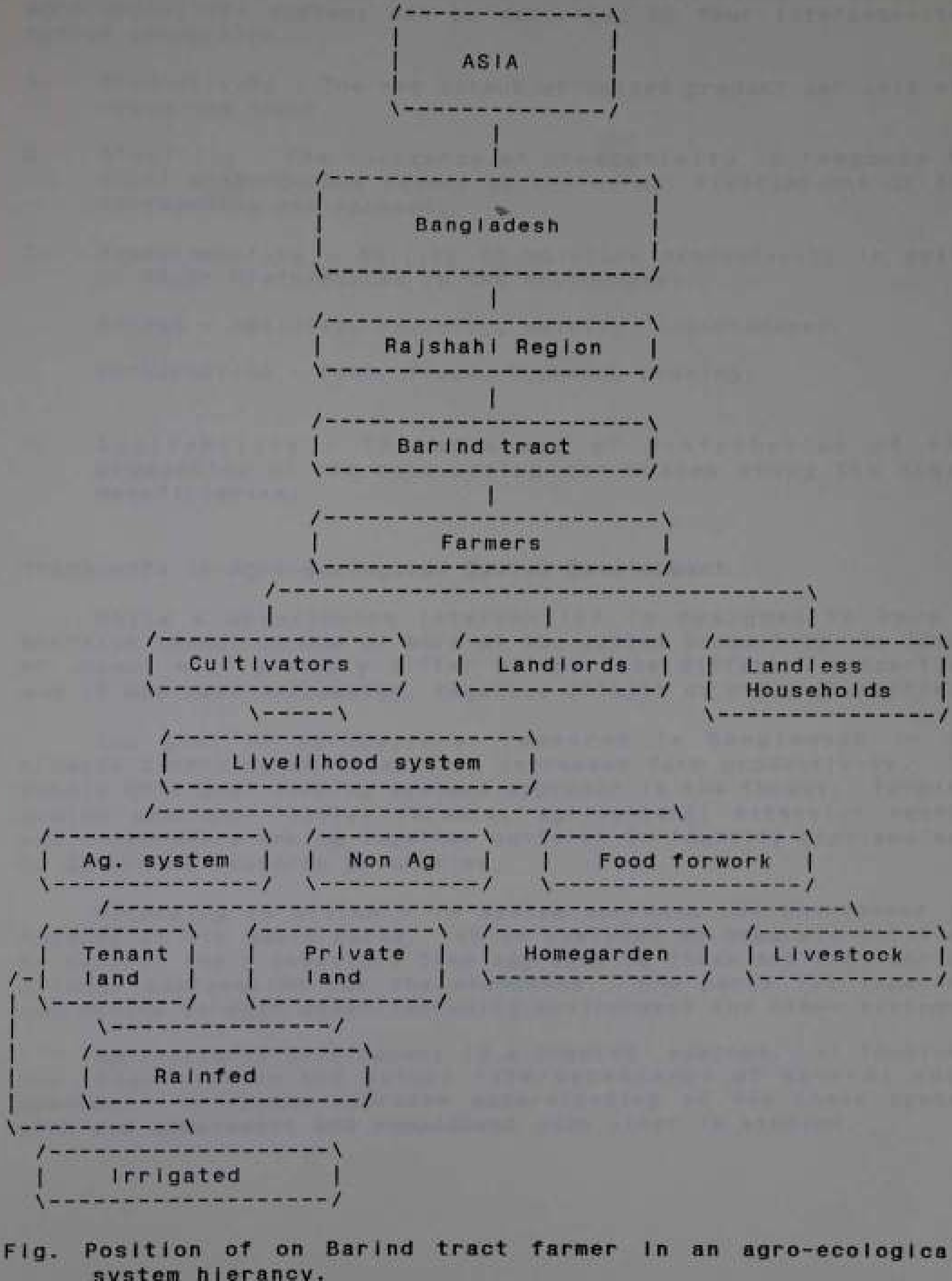

Fig. Position of on Barind tract farmer in an agro-ecological system hierancy.

Agro-ecological system properties - The distinctive behaviour of agro-ecological systems can be described by four interconnected system properties.

1. Productivity - The net output of valued product per unit of resources input.

2. Stability - The constancy of productivity in response to small disturbances caused by the normal fluctuations of the surrounding environment.

3. Sustainability - Ability to maintain productivity in spite of major disturbances in the environment.

   Stress - Salinity, toxicity, acidity, indebtedness.

   Perturbation - Pest, flood, typhoon, pruning.

4. Equitability - The evenness of distribution of the production of the agro-ecological system among the human beneficiaries.

Trade-offs in Agro-ecological System Development

While a development intervention is designed to have a positive impact on one or more of the system properties its level of impact will probably differ between the different properties and it may have unexpected, negative effects on other properties.

The goal of agricultural research in Bangladesh is to provide technologies to sustain increased farm productivity. To attain this goal farming systems approach is the thrust. Farming system approach involve farmers, agricultural extension agents and researchers coming together on-farms to identify problems and to determine research priorities.

According to Dilan - In system approach the phenomence is reduced to its basic parts. It is analysed as separate entities to explain their behavior, then aggregating these explanations as a total explanation for the phenomena. How parts fit together and relate to each other including environment and other systems.

Agricultural development is a complex systems. It involves the interrelation and mutual interdependence of several sub-systems. In system approach understanding of how these system work and complement and supplement each other is studied.

Prospect of Contribution to Rural Development

Four out of every five persons live in rural areas so rural development is very important. The rural development approach has changed from a sectorial consideration to an integrated view of the rural community.

Integrated rural development involves the development of natural and human resources. It provide full employment and equitable distribution of the proceeds of development. The social economic and psychological background of the people is considered. Agriculture, dairying, fisheries, poultry, cottage and small scale industries, development of roads, transport and communication, education and public health facilities.

CONCEPT OF FARMING SYSTEMS AND FARMING SYSTEMS RESEARCH

S.M. Altaf Hossain

Introduction

Farming is an activity carried out by households on holdings that represent managerial units organized for the economic production of crops, livestock (Ruthenberg, 1990) and fishes. It is concerned with an activity of fundamental importance to all communities and consists of a purposeful blend of science and non-science (Spedding, 1988). The farming activities are carried in a systematic and well arranged pattern in a community centering around a household - the unit of activity for producing a dependable and continuous food supply and many of their needs such as clothing and shelter and surpluses for sale' . The owners of the households i.e. The farmers have at their disposal certain physical, biological and socio-economic resources on the basis of which they can arrange their farm production with the technology they have. The whole activities of the farm for the purpose of production and consumption result in a system. 'A system is a group of interacting components operating together for a common purpose capable of interacting as a whole to external stimuli : it is unaffected directly by its own outputs and has a specified boundary based on the inclusion of all significant feed backs' (Spedding, 1988). This interacting behavior of farming activities is called the farming systems.

Concept of Farming Systems

Farming system has been defined in various ways. According to CGIAR (1976) "a farming system (or farm system or whole farm system) is not simply a collection of crops and animals to which one can apply this input or that and expect immediate results. Rather, it is a complicated interwoven mesh of soils, plants, animals, implements, workers, other inputs, environmental influences with the strands held and manipulated by a person called the farmer who, given his preferences and aspirations, attempts to produce output from the inputs and the technology available to him. It is the farmer's unique understanding of his immediate environment, both natural and socio-economic, that results in his farming system".

"Farming systems are defined by their physical, biological, and socio-economic setting and by the farm families' goals and other attributes, access to resources, choices of productive activities (enterprises), and management practices" (Shaner et al., 1982). Shaner et al. (1982) consider a farming system as a unique and reasonably stable arrangement of farming enterprises that the household manages according to well - defined practices in response to physical, biological and socio-economic environments and in accordance with the household's goals, preferences, and resources. The farming system is part a of

larger systems - e.g. the local community. This can be divided into subsystems like cropping systems, animal production systems, fish production systems, agro-forestry production, etc.

Farming Systems Research

The farmers in subsistent farming systems generally maintain different enterprises in their farms for sustenance (Tables 1 and 2). For survival they are very dynamic in selecting enterprises and in adopting technology. The farming systems of these small farmers are very sensitive in this respect. If the researchers fail to understand their felt need, whatever good technology the scientists develop will not be adopted by the farmers. This has happened in almost all developing countries of the world. The researchers should have the capability to analyse the farmers' problems and farm environment. Generally, for a specialist it is very difficult to analyse the environment which consists of a series of interacting factor. As already mentioned interacting factors in production environment form a system or systems. The problems are often highly complex and related to socio-economic and bio-physical factors (Hossain, 1988).

Different components of agricultural systems must be analysed in view of identifying farmers' problems through system approach otherwise the following complications may arise.

1. The development and research priorities may be established in isolation from the systems context and are sometimes inappropriate.

2. Poor communication among researchers, development workers and farmers.

3. Plans, programmes and projects may tend to concentrate on productivity issues while neglecting issues of stability, sustainability and equity.

4. Poor knowledge of the fools may be used to analyse the systems and carry out inappropriate research and development interventions (Chiangmai University, 1987).

However, now-a-days, some researchers and development workers have recongnised that rural people have great richness of knowledge about their resources, environments and farming practices and likewise are often experimenters, risk takers, innovators and intensifiers, diversifiers and practioners of great common sense, who have remarkable capacities to adapt, to change and constraints to evolve their techniques over time. These technical knowledge systems of the farmers have been ignored by the researchers, planners and development workers. Rather top-down approaches are being tried with least success and quite often displacing or neglecting resources-poor people of the rural society (Thrupp, 1987). As a result "resource-poor farmers are ---distrustful because they live in conflict ridden societies

where they are very vulnerable to oppression---they know that knowledge is power --the closer the researchers gets to the real life pulse of the society, higher will be the resistance, as well as the great the appreciation and regards" (Wilson, 1987).

The farmers for their survival have been developing technology/systems through informal research and development in their environment since the dawn of civilization by utilizing their inherent knowledge and wisdom. From the last two decades a great emphasis has been placed on the utilization of the farmers' technical knowledge and wisdom to the formal research system through their participation for the improvement of farms in holistic way. This approach has been termed as farming systems research (FSR). Shaner et al. (1982) have described this as an approach to agricultural research and development that views the whole farm as a system and focuses on (1) the interdependencies between the components under the control of the farm household and (2) how those components interact with the physical, biological and socio-economic factors not under the household's control.

Farming systems research addresses itself to each to the farm's enterprises, and to the inter relationships among these enterprises and between the farm and its environment. It employs information about the farm's various production and consumption systems and about farm environment (physical, institutional, social and economic) to increase the efficiency with which the farm utilizes its resources (Zandstra et al. 1981).

FSR Versus Conventional Agricultural Research

1. Agricultural research is search for additional knowledge and for practice, in an almost infinite space of not yet discovered knowledge on the behaviour of species, varieties and combination of practices in any given agro-climatical zone. Farming systems research informs about the existing situations and improves prognosis. One of its major tasks is the testing of innovations in the systems. It thus contributes to the relevancy of biological science research work.

2. Agricultural research is usually commodity or disciplined oriented. Solutions with the highest technical efficiency may not be optimal solutions in economic terms, and optional solutions for given crop may not be optimal context. It is the test of farming systems research to assess the worth whileness of innovations in the context of the total farm unit. Farming systems research is thus a major tool to close the 'gap' between agricultural research and performance in the actual farms (Ruthenberg, 1980).

Categories of FSR

1. FSR sensu stricto is the study of farming systems per se, as they exist, typically the analysis goes deep, (technically and socio-economically) and the object is academic or scholarly, rather than practical, the view taken nominally 'holistic'.

2. New farming system development takes as its starting point the view that many tropical farming systems are already so stressed that radical restructuring rather than step -wise change is necessary, the invention, testing and explosion of new systems is therefore the object.

3. On-farm research with farming systems perspective is a practical adjunct to agricultural research which starts from the percept that only farmer experiences can reveal to the researcher what farmers really need; typically, the on-farm research with farming systems perspective process isolates a subsystem of the whole farm, studies it in just sufficient depth (no more) to gain the necessary farming systems perspective and proceeds as quickly as possible to experiment on-farm with farmers' collaboration, there is an implicit assumption that step-wise change in an economically favourable direction is possible and worth seeking (Simmonds, 1985 and Spedding, 1988).

The design of agricultural research strategies and the adoption of innovations by the farmers is greatly enhanced if crop research generally integrated with cropping systems research, if livestock is integrated with cropping systems research, if livestock is integrated with livestock systems, if fisheries research is integrated with fisheries systems research and finally all with the farming systems (Ruthenberg, 1980). FSR can be described in different ways. Some of them are as follows.

1. FSR is a method of (i) identifying constraints in an interdisciplinary setting, (ii) developing a broad and balanced philosophy of farming systems, (iii) putting a proposed method of research to a thorough test and (iv) identifying the complete framework of a system.

2. FSR is meant to be a holistic approach to research and involves listening to farmers' perceptions of problems and reporting to what farmers have to say.

3. FSR is a process that moves from general to particular (area selection, identification of target farmers, specific constraints etc.), while extension moves from the specific to general - the goal is to transfer technology to all the farmers where the technology is appropriate.

Process of FSR

The process of FSR involves the following steps:

1. Selection of a target community for research

2. Description of the farming community

   a). What do farmers do

   b). Why do they do what they do

   c). Description of environment

   This includes physical, social, biological, economic and political environments.

3. Problems identification and discussion with farmers

4. Seeking solutions to identified problems with farmers

5. Testing solutions with farmers

6. Extension of viable solutions by encouraging farmers in the role of informal extension agents.

Characteristics of FSR

Some of the important characteristics are given below:

1. It considers individual farmer.

2. It involves an interdisciplinary team.

3. It aims for a holistic approach.

4. It is the work jointly carried out by the researchers, extension workers, and the farmers.

5. It aims to be practical rather than theoretical.

6. It complements conventional research.

7. FSR, of necessity, must be applied research.

8. FSR does not require in-depth research, but a broad range of investigations directed at an integration of the relationships among the salient features of the systems, not a total knowledge of the system.

9. It is a comprehensive method for identification and solutions of problems in whole farm setting.

10. It is iterative and dynamic for understanding the systems and record the change of the systems for intervention and further research.

11. It is responsible to the community for its development.

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Table 1. Farm family and population distribution under different production systems of Naogaon FSR site (FSRDP 1987).

Farming systems	Farm family		Population	
	Total	Percent	Total	Percent
1. Crop-Cattle-Buffalo-Poultry	4	1.18	46	2.35
2. Crop-Cattle-Goat-Poultry	11	3.24	74	3.78
3. Crop-Cattle-Poultry	73	21.47	469	23.95
4. Crop-Cattle-Goat	3	0.88	14	0.77
5. Crop-Cattle	13	3.82	83	4.24
6. Crop-Poultry	45	13.24	248	12.66
7. Crop	12	3.53	75	3.82
8. Landless-Cattle-Goat-Poultry	1	0.29	3	0.15
9. Landless-Cattle-Poultry	10	2.94	58	2.94
10. Landless-Goat-Poultry	2	0.59	9	0.45
11. Landless-Cattle	2	0.59	9	0.51
12. Landless-Poultry	41	12.06	226	11.54
13. Truelandless-Cattle	1	0.29	1	0.05
14. Truelandless-Poultry	20	5.88	110	5.62
15. Landless with homestead	49	14.41	274	13.98
16. Landless without homestead	53	15.59	258	13.18
Total	340	100	1959	100

Table 2 : Cropping patterns observed in the CSR site Ujan Bollor under rainfed condition (FSRDP 1987)

Patterns	Percent area						
	1979-80 (Banchmark)	1980-81	1981-82	1982-83 (Monitored)	1983-84	1984-85	1985-8
1. Jute-T.Aman (M)-Fallow	17.14	-	-	-	11.58	-	1.08
2. T.Aus (M)-T.Aman (L) - Fallow	13.08	-	5.56	-	19.92	4.18	3.12
3. B.Aus (L)-T.Aman (L) - Fallow	10.52	29.41	16.67	24.56	11.15	19.28	20.57
4. B.Aus - T.Aman (M) - Fallow	9.17	5.88	5.56	-	-	1.11	1.41
5. Jute - T.Aman (L) - Fallow	7.37	17.65	-	8.16	15.70	-	4.67
6. T.Aus (M) - T.Aman (M) - Fallow	5.41	-	11.11	-	-	-	5.40
7. T.Aus (L) - T.Aman (L) - Fallow	4.81	-	-	-	-	-	-
8. B.Aus (L) - T.Aman (L) - Pulse	4.21	11.76	-	8.16	15.70	-	4.67
9. Fallow - Fallow - Boro (L)	3.91	-	-	-	-	-	-
10. B.Aus (L) - T.Aman (L) - Wheat	3.46	11.76	-	-	-	-	6.16
11. Jute - T.Aman (M) - Vegetable	3.36	-	-	-	-	0.55	0.12
12. Jute - T.Aman (L) - Pulse	3.31	5.88	-	-	-	-	0.20
13. Jute - T.Aman (L) - Vegetable	2.40	-	5.56	-	-	-	-
14. B.Aus - (L) - T.Aman (M) - Wheat	2.40	-	5.56	12.25	10.91	-	2.16
15. B.Aus - T.Aman (L) - Vegetable	2.10	-	5.56	-	-	-	-

(Table 2 Contd.)

Patterns	Percent area						
	1979-80 (Banchmark)	1980-81	1981-82	1982-83 (Monitored)	1983-84	1984-85	1985-8
16. Jute - T.Aman (M) - Pulse	1.95	-	-	16.33	-	-	2.96
17. Jute - T.Aman (M) - Boro	1.95	-	-	-	-	-	-
18. T.Aus (M) - T.Aman (L) - Pulse	1.80	-	5.56	16.33	-	-	2.96
19. Jute - Fallow - Vegetable	1.50	-	-	-	2.37	0.70	0.21
20. Jute - T.Aman (Pai) - Mustard	-	5.88	-	-	-	2.51	-
21. B.Aus (L) - T.Aman (Pai) - Fallow	-	5.88	16.67	6.12	-	-	2.38
22. T.Aus (M) - T.Aman (Pai) - Fallow	-	5.88	-	-	-	1.12	3.38
23. Jute - T.Aman (Pai) - Wheat	-	-	5.56	-	-	9.49	0.89
24. Jute - T.Aman (Pai) - Fallow	-	-	5.56	-	-	-	0.06
25. B.Aus (L) - Fallow - Vegetable	-	-	5.56	-	-	0.55	0.25
26. B.Aus (M) - T.Aman (M) - Wheat	-	-	-	12.25	3.80	-	-
27. Jute - T.Aman (M) - Wheat	-	-	-	-	9.01	30.00	7.90
28. B.Aus (L) - T.Aman (M) - Pulse	-	-	-	-	4.74	1.69	1.87
29. Jute - Fallow - Mustard	-	-	-	-	4.27	-	-
30. Jute - Brinjal	-	-	-	-	2.85	-	-
31. Jute - Chilli	-	-	-	-	1.42	-	-
32. B.Aus (L) - T.Aman (Pai) - Wheat + Pulse	-	-	-	-	1.19	1.96	-

able 2 Contd.)

Patterns	1979-80 (Banchmark)	1980-81	1981-82	1982-83 (Monitored)	1983-84	1984-85	1985-86
	Percent area						
Jute - T.Aman (Pal) - Vegetable	-	-	-	-	1.19	-	0.55
T.Aus (M) - T.Aman (M) - Wheat	-	-	-	-	-	1.39	1.32
B.Aus (L) - Fallow - Chilli	-	-	-	-	-	0.55	0.05
B.Aus (L) - T.Aman (Pal) - Wheat	-	-	-	-	-	4.75	2.67
B.Aus (L) - Brinjal	-	-	-	-	-	2.25	-
Jute - T.Aman (L) - Mustard	-	-	-	-	-	2.34	0.09
T.Aus (M) - T.Aman (Pal) - Pulse	-	-	-	-	-	-	3.45
Jute - T.Aman (Pal) - Pulse	-	-	-	-	-	-	2.37
Seedling - Fallow - Vegetables	-	-	-	-	-	-	0.54
B.Aus (L) - T.Aman (Pal) - Pulse	-	-	-	-	-	-	10.84
Jute - Seedling - Vegetables	-	-	-	-	-	-	1.07
T.Aus (M) - T.Aman (M) - Pulse	-	-	-	-	-	-	2.43
Fallow - Seedling - Vegetables	-	-	-	-	-	-	1.07
T.Aus (M) - T.Aman (L) - Wheat	-	-	-	-	-	-	2.25
T.Aus (M) - T.Aman (L) - Vegetables	-	-	-	-	-	-	0.24

(Table 2 Contd.)

Patterns	Percent area						
	1979-80 (Banchmark)	1980-81	1981-82	1982-83 (Monitored)	1983-84	1984-85	1985-86
33. Jute - T.Aman (Pal) - Vegetable	-	-	-	-	1.19	-	0.55
34. T.Aus (M) - T.Aman (M) - Wheat	-	-	-	-	-	1.39	1.32
35. B.Aus (L) - Fallow - Chilli	-	-	-	-	-	0.55	0.05
36. B.Aus (L) - T.Aman (Pal) - Wheat	-	-	-	-	-	4.75	2.67
37. B.Aus (L) - Brinjal	-	-	-	-	-	2.25	-
38. Jute - T.Aman (L) - Mustard	-	-	-	-	-	2.34	0.09
39. T.Aus (M) - T.Aman (Pal) - Pulse	-	-	-	-	-	-	3.45
40. Jute - T.Aman (Pal) - Pulse	-	-	-	-	-	-	2.37
41. Seedling - Fallow - Vegetables	-	-	-	-	-	-	0.54
42. B.Aus (L) - T.Aman (Pal) - Pulse	-	-	-	-	-	-	10.84
43. Jute - Seedling - Vegetables	-	-	-	-	-	-	1.07
44. T.Aus (M) - T.Aman (M) - Pulse	-	-	-	-	-	-	2.43
45. Fallow - Seedling - Vegetables	-	-	-	-	-	-	1.07
46. T.Aus (M) - T.Aman (L) - Wheat	-	-	-	-	-	-	2.25
47. T.Aus (M) - T.Aman (L) - Vegetables	-	-	-	-	-	-	0.24

(Table 2 Contd.)

Patterns	1979-80 (Banchmark)	1980-81	1981-82	1982-83 (Monitored)	1983-84	1984-85	1985-86
	Percent area						
48. T.Aus (M) - T.Aman (Pal) - Vegetables	-	-	-	-	-	-	0.36
49. T.Aus (Pal) - T.Aman (M) - Pulse	-	-	-	-	-	-	0.44
50. T.Aus (M) - T.Aman (Pal) - Wheat	-	-	-	-	-	-	1.10
51. T.Aus (Pal) - T.Aman (Pal) - Pulse	-	-	-	-	-	-	0.92
52. B.Aus (L) - T.Aman (L) - Mustard	-	-	-	-	-	-	0.45

NOTES OF FARMING SYSTEM

Dr. Altaf Hossain

SYSTEM

A system is defined as an assemblage of elements contained within a boundary such that the elements within the boundary have strong functional relationships with each other, but limited, weak on non-existent relationship with elements in other assemblages; the combined out come of the strong functional relationships within the boundary is to produce a distinctive behaviour of the assemblage such that it responds to many stimuli as a whole, if the stimulus is only applied to one part.

Agro-ecosystem properties

1. Productivity	:	Output of valued product/resource input.
2. Stability	:	Constancy of productivity in the face of small disturbances.
3. Sustainability	:	Ability of agro-ecosystem to maintain productivity inspite major disturbances.
4. Equitability	:	Even ness of distribution of the productivity among the actual human beneficiancy.

Elements of agro-ecosystem

1. Purpose
2. boundary
3. Context or environment
4. Component
5. Interaction
6. Resources
7. Input
8. Product or performance
9. By product

Cropping systems

"__________ the crop production activity of a farm. It comprises of all components required for the production of the set of crops of farm and the relationship between them and the environment. These components include all necessary physical and biological factors as well as technology, labour and management". Zandstra et.al. (1981).

Farming systems

"A farming system (or farm system or whole farm system) is not simply a collection of crops and animals to which one can apply their input or soils, plants, animal, implements, workers, other inputs, environmental influences with the strands held and manipulated by a person called the farmer who, given his preferences and aspirations, attempts to produce output from the inputs and the technology available to them. It is the farmers unique undersanding of this immediate environment both natural and socio-economic, that results in his farming system" (Moseman et.al. 1980).

Farming systems research

"Farming systems research is an approach to agricultural research and development that view the whole farm as a system and focuses on (1) the interdependencies between the components under the control of members of the farm household and (2) how these components interact with the physical, biological and socio-economic factors not under the households control" (Shaner et.al. 1982).

Cropping systems research

The cropping system research is an integrated approach to develop more production and profitable pattern acceptable to the farmers by inclusion or exclusion of crops and/or varieties and by improving efficiency of management practices.

FSR is a method of

0 identifying constraints in a multi-disciplinary setting;

0 developing a broad and balanced philosophy of farming systems;

0 putting a proposed method of reason to a thorough test;

0 identifying the complete framework of a system.

FSR is ment to be a holistic approach to research and involves listening to farm perceptions of problems and responding what farmers have to say.

CHARACTERISTICS OF FSR

a) It considers individual farmers.

b) It involves a multidisciplinary team.

c) It aims for a holistic approach.

d) It aims to be practical rather that theoretical.

e) It complements convertional research.

f) FSR, of necessity, must be applied research.

g) FSR does not require in-depth research, a broad range of investigations directed an integration of the relationships among salient features of the system, not a total knowledge of the system.

PROCESS OF FSR

a) Selection of a target community for research.

b) Description of the farming community

- What do farmers do
- Why do they do what they do
- Description of the environment
  - Ø Physical
  - Ø Social
  - Ø Biological
  - Ø Economic
  - Ø Political

c) Problem identification and discussion in farmers

d) Seeking solutions to identified problems with farmer

e) Testing solutions with farmers

f) Extension of viable solutions by encourage farmers in the role of informal extension agents.

FSR VS EXTENSION

FSR is a process that moves from general to particular (area selection, identification of target farmers, specific constraints, etc.) while extension moves from the specific to general ______ the goal is to transfer technology to all the farmers where the technology is appropriate.

Evolution of agricultural education system

1818	Bengal Veterinary College
1922	Agricultural School
1938	Bangladesh Agriculture Institute
1961	Bangladesh Agricultural University
1979	Patuakhali Agricultural College
1984	Institute of Post-graduate Studied in Agriculture.

Evolution of research system

1908	Agricultural Research Laboratories at Dhaka.
1955	Bangladesh Forest Research Institute
1957	Bangladesh Jute Research Institute
1959	Bangladesh Academy for Rural Development
1961	Bangladesh Agricultural University
	The Atomic-Energy Agricultural Centre
1962	Fisheries Research Station
1970	Bangladesh Rice Research Institute
1973	Sugarcane Research and Training Institute
	Bangladesh Agricultural Research Council
1976	Bangladesh Agricultural Research Institute
1977	Bangladesh Institute of Nuclear Agriculture
1984	Fisheries Research Institute
1985	Livestock Research Institute

Evolution of extension systems

1865	Directorate fo Forestry
1870	Section of Agriculture
1905	Department of Agriculture
1939	Directorate of Livestock Services
1940	Rural Development Department Jute Regulation Directorate
1952	V.A.I.D
1959	BARI, BWDB
1961	Agricultural Information Service
1962	Training Institute of Fisheries
	Bangladesh Agricultural Development Corporation.
1964	Bangladesh Fisheries Development Cooperation
1972	BRDB, Cotton Development Board, Bangladesh Tobacco Development Board
1974	Directorate of Seed Certification Agriculture

Evolution of Production Systems

Ø PRE VEDIC PERIOD

Ø * Domestication of plant and animal started before the beginning of the written history

* It was in the Neolithic or New Stone Age that man firs practiced agriculture-crop culture which included the raising of domestic animals.

Ø * The Dravidians devised land preparatory implements like plough and established crop-livestock farming systems on sustainable foundation in Bengal.

Ø * Rice cultivation started from the very beginning of crop culture followed by sugarcane, cotton and other crops.

* The Dravidians were mainly crop husbandry people.

Ø VEDIC PERIOD

Ø * The Aryans after the conquest of Bengal took up farming as the sacred and noble profession

* The Aryans were basically animal husbandry people

Ø * They integrated crop-livestock farming systems

* Farming was a profession of the rulers

* Cows are goddess-Sree Krishna

* Sheeta was uncovered from the soil with the plough by Mithilar, a saint and king.

* Bala Ram elder brother of Sree Krishna, was decorated with the title of plough holder.

Ø * The farming activities were integrated with the religious practices and most of the activities could not be separated from this.

Ø * Crops grown: Rice, cotton, sugarcane, wheat, barley, jute, mango, ginger, turmeric, pumpkin, gourd cucumber, pepper, turnip, sesame, mustard, cabbage, potato, radish, pulses, etc.

Ø * Tree planting the preservation was one of the of fundamental articles of hindu religion.

Ø * The Vedic Aryans appear to have large forests at their disposal for securing timber, and herbs for medicinal purposes.

Ø * Animals : Cows, sheep, goat, horse.

Ø * Cow had already become the very basis of rural economy.

Ø * Sheep and goat were offered is sacrificed victims and their wool as clothing.

Ø * Crop rotation was practiced.

Ø * Irrigation and multiple cropping were developed.

Ø * Crop culture and animal husbandry developed to a degree of skill ravely known in other parts of the world.

Farming community

Ø * The village communities are little republics, having nearly every thing that they want within themselves and almost independent of any foreign relations. They seem to last where nothing else lasts. Dynasty after dynasty tumbles down, revolution succeeds to revolution, Hindu Pathan, Mughal, Mathatta, Sikh, English are in turn their master but the village communities remain the same (Sir Charles Methcalfe 183Ø).

Ø * The farmers in Bengal watch and intelligently follow the .... They are ready to procure such implements .... are suitable to their wants and within their means (Ashley Eden, Lt Governor of Bengal, 1877-82).

Ø * The estimates show the speed of adjustment in agriculture in Bengal was at least as fast as that in the United States and Hungary in the late nineteenth century.

Ø * The estimates of the supply response of farmers in show that they were both national and sensitive to economic incentives (Khan, 1982).

Ø * The existing crop culture was developed by the farmers over the years and through the process of informal research development. Due to high population pressure the area cropped more than once nearly.

Cropping systems research

BRRI	:	1976
SRTI	:	1976
BWDB	:	

1st National Workshop, 1978 Organized by BRRI

Dr. Ameerul Islam, EVC, BARC proposed in his introductory speech for farming systems research instead of cropping systems research.

BARC constituted National Workshop group on farming systems, 1983. The working group prepared "Resume of activities on cropping system" a project proposal. Dr. Carangal was the consultant for the project preparation.

Ø Due to fund and manpower constraint only the cropping systems component of FSR was taken into consideration other components would be incorporated later (NWGFS).

Ø Workshop, 1980 BRRI
NCCSRP, 1979-80

Participating institutes/organization

BRRI (3) BAU (4) SRTI (1)	Coordinating
BARI (2) BJRI (4) MCC (2)	body : BARC
BWDB (2)	

National Objectives

1. To help attain self-sufficiency in food at higher level of per capital conception and with more balanced diets through the increase in production of cereals, oil seeds, pulses, vegetables etc. and

2. To help increase income and income generating activities and thereby upgrading the quality of life of the farming community.

Ø Workshop, 1981, BRRI

Ø 1st National Workshop, BARI-BARC, 1983

Ø Workshop, 1984, BARC

Recommended for FSR (NCFSRP) NCFSRP has started functioning since July, 1985.

Objective

1. To help obtain self-sufficiency in food at higher level of per capital consumption and with more balanced diets through the increase in production of cereals, oil seeds, pulses, vegetables, fruits fish, milk, mutton, beef, egg etc.

2. To help increase income and income generating activities of the poor farmers.

Participating institutes

BARI, BAU, SRTI, FRI, BARI, BJRI, and BLRI.

Change of system overtimes

Sl. No.	Farming Systems	Farm		
		1985-86	1986-87	1987-88
1.	Crop-Cattle-Goat-Poultry-Fish	26	40	24
2.	Crop-Cattle-Goat-Poultry	11	7	8
3.	Crop-Cattle-Poultry-Fish	43	52	63
4.	Crop-Cattle-Poultry	18	17	13
5.	Crop-Cattle-Goat	3	2	-
6.	Crop - Cattle - Fish	2	2	2
7.	Crop - Goat - Poultry - Fish	3	5	4
8.	Crop - Goat - Poultry	1	2	-
9.	Crop - Goat - Fish	1	-	-
10.	Crop - Poultry - Fish	1	10	18
11.	Crop - Sheep - Poultry - Fish	1	-	-
12.	Crop - Goat	1	-	-
13.	Crop - Poultry	15	11	14
14.	Crop - Fish	11	13	12
15.	Crop	7	5	6
16.	Cattle - Goat - Poultry - Fish	1	3	1
17.	Cattle - Goat - Poultry - Fish	6	3	1
18.	Cattle - Goat	2	-	-
19.	Cattle - Poultry	3	2	2
20.	Cattle	1	-	-

Sl. No.	Farming Systems	Farm		
		1985-86	1986-87	1987-88
21.	Goat - Poultry - Fish	1	-	-
22.	Goat - Poultry	4	5	3
23.	Goat - Fish	1	-	-
24.	Goat	2	-	-
25.	Poultry - Fish	2	2	3
26.	Poultry	3	4	3
27.	Fish	2	1	-
28.	No enterprise	6	2	3
29.	Crop - Cattle	-	2	-
30.	Cattle - Fish	-	-	1

Achievement of CSR

The programme is oriented towards : (1) testing, adjusting and modifying the existing agricultural technology with farmers' participation; (2) conducting research on a cropping pattern basis to evaluate the interactions between different crops; (3) combining the agronomic and socio-economic research components to get a better understanding of existing farming practices; and (4) developing systems for technology transfer through a better linkage between research and extension.

Participating organizations

Bangladesh Rice Research Institute	(BRRI)
Bangladesh Agricultural Research Institute	(BARI)
Bangladesh Jute Research Institute	(BJRI)
Bangladesh Agricultural University	(BAU)
Bangladesh Water Development Board	(BWDB)
Sugarcane Research and Training Institute	(SRTI)
Mennonite Central Committee	(MCC)

1. The results indicate that there is a high potential to increase production of the common cropping patterns practiced by the farmers of Bangladesh by introducing simple changes in the agronomic practices followed by the farmers.

2. The major scope for increasing production in replacing the local or existing varieties by improved or high yielding varieties and by modifying some agronomic practices such as rates of fertilizer, seed rates, age of seedlings and planting dates.

3. Land types, rainfall and irrigation are the major determinants of the cropping patterns but the production of the patterns depends on other factors, like soils and management practices.

4. There are innunerable cropping patterns in existance often with a bias for rice production. Increase where irrigation is available and irrigation schedules are reliable, the farmers prefer the cropping pattern rice (Boro) - rice (T.Aman).

5. In rainfed areas, where the residual moisture is high after harvesting rice (T.Aman), the main cropping patterns are of the type rice (direct seeded aus) rice (T.Aman) - Rabi crops (including mustard, potato and pulses). The yields of the rabi crops in this pattern are generally low because of late planting. In rainfed highlands and rainfed medium lowlands, the most common cropping patterns are rice (Aus) - rice (T.Aman) - Fallow - Mustard, or Jute - Fallow - Mustard. Late planting of mustard considerably decreases its yields, farmers usually plant this crop when the land remains fallow after harvesting rice (Aus) or Jute.

6. The most suitable crop varieties for improving production of different cropping patterns are Rice (Aus), BR-1 (direct seeded or transplanted) Rice (T.Aman) - BR-11, Pajam, Nizershail; Rice (Boro), Purbachi, Pajam; Jute, CC-33, Ø-9897, D-154; Wheat, Balaka, Sonalika, Potato; Cardinal, Diamant, Mustard; SS-75, Tori-7.

7. Yield of HYV rice above 3.5 t/ha can be expected if they are fertilized with 8Ø-6Ø-4Ø kg/ha NPK, and other recommended agronomic practices are followed. The varieites Pajam and purbachi yield from 2.5 to 3.5 t/ha, using lower fertilizer rates, like 6Ø-4Ø-4Ø or 4Ø-2Ø-Ø kgs/ha NPK.

8. The addition of Zn and S generally causes an increase of 5ØØ-8ØØ kg/ha over the yield obtained when only NPK at the rate mentioned above is applied.

9. There is indication that the production of land cultivated with sugarcane can be increased by intercropping winter crops like potato, mustard, lentils, chickpea, radish, onions and spinach. There systems require further evaluations in the sugarcane growing areas.

OVERVIEW OF FARMING SYSTEM RESEARCH

M. Z. Abedin

Since the beginning of the century the population through out the world in general and in South Asian in particular, has increased at a dramatic rate. But the food production has not increased so dramatically to cope with the food requirements of the human being. Further, the allout efforts of to produce food for human being first has reduced the opportunity to produce feed for the animals that directly or indirectly supports the food production. Changes in environment making it favourable for crop production system has also adversely affected the fisheries resources in several areas. Over the years, most of the arable land has already been brought under cultivation. Therefore, opportunities to bring more land under cultivation is very minimum.

To meet the situation with a more pragmatic approach, it is necessary, therefore, to analyse the possibilities of producing more of food, feed and fish. The possibilities of increasing the net crop area is considered to be minimum while opportunities for raising more food lies in increasing yields per unit area, increasing cropping intensity and increasing both yields and cropping intensity.

On-station experiment at national and international research institutes have demonstrated that yields of crops could be raised several fold over the farmers existing levels provided right technology with right management is adopted. Analysis of the increase in rice production reveals that the increase in rice production during the last 30 years has largely come from use of irrigation, modern varieties and fertilizers. Even this increase in production is slowly reducing because of slowing down of the initial rate of adoption of the modern technology. A wide gap between the experimental station yield and farmers yield still remains. Even a wide gap exists between the yield level obtainable at the farm level with proper technology and the actual farm level yield.

While the scientists are spending lot of their time on the research stations, in developing improved and better technologies the farmers are continuing with their traditional practices. Recommendations made by scientists are not being adopted in many cases and more are being rejected after some years. Our understanding of such farmer behaviour revealed that farmers very often rejected technology because he can not manage to buy the inputs, and he does not have accessibility to credit sources required to follow the recommendation and he is not adequately trained also on the use of technologies. In other words, the technologies recommended were not appropriate to the farmers resource base and the skills of the farmers. Farmers would like to see that the technologies are compatible with his resources, physical and climatic conditions, biological conditions and

socio-economic conditions. It has to meet the family goals, lower the risk and raise the income. If the recommended technology does not satisfy these conditions, the farmers are not going to adopt it.

If we like to have a closer look at the reasons why the technologies generated through the hard work of the experienced scientists become inappropriate, we find that the physical environment of the research stations are quite different than that of the small farmers. Therefore, the physical responses from trials held on experiments station differ from those which could be found on small farms. Secondly, the level of crop management and input use as well as the degree of control of irrigation and pests on experiment stations are high. Generally, farmers are not willing or able, because of their socio-economic situations, to follow optimal levels of management on their farms. Thirdly, general recommendations have been given for large geographical areas such as regions. But large differences exist in the agro-climatic and the socio-economic situation of farmers within relatively small areas even within a village. The recommendations suited for some farmers are not suited for others. Finally, scientists generally feel they know what is best for farmers. Recommendations or solutions have been made without a clear understanding of the causes of problems faced by farmers in increasing production and net income. Recommendations have been discipline - or at most commodity-based whole farmers problems often do not fall within the realm of one discipline or commodity.

During FSR a strong linkage should develop so that farmers, researchers and extension workers participate in technology generation process. The standard approach is that research results are provided to the extension service which in turn extends recommendations to farmers. Problems encountered by farmers are to be brought back to the researchers by extension personnel. This approach did not work well in practice. Generally, the communication went one way : top down, from the researcher to the extension worker to the farmer.

Farming Systems Research Methodology is increasingly being used because of the shortcomings of the traditional commodity oriented top-down research and extension approach for reaching small farmers. FSR encourages the direct communication of researchers, farmers and development workers. Farming Systems Research is an approach to research which helps assure that the technology recommended to farmers is suited to them (which means it will increase their production and improve their welfare) and consequently will be adopted by them.

Commodity and discipline oriented research conducted on experiment stations is essential for the formation of new crop technology.

What is farming systems research

Farming systems research is an approach to agricultural and development that (1) views the whole farm as a system and (2) focuses on the interdependencies among the components which interact with the physical, biological and socio-economic factors not under the household's control. The approach involves selecting target areas and farmers, identifying problems and opportunities, designing and executing on-farm research and evaluating and implementing the results. In the process, opportunities for improving public policies and support systems affecting the target farmers are also considered.

Farming systems research

(1) is conducted with a recognition of and focus towards the interdependencies and interrelationships that exist among elements of the farm system, and between these elements and the farm environment; and

(2) is aimed at enhancing the efficacy of farming systems through the better focusing of agricultural research so as to facilitate the generation and testing of improved technology (CGIAR TAC Review of FSR).

For the process to be considered FSR, one does not have to address all aspects of a farming system in on-farm trials. Cropping and livestock systems and even commodity research may qualify. What is needed is for the research on subsystems - e.g. cropping systems to be taken within the context of the whole farm. In fact, almost all FSR on-farm trials are focused on sub-systems.

Farming systems research has the following characteristics

It views the farm or production unit and the rural household or consumption unit - which in the case of small farmers are often synonymous - in a comprehensive manner.

FSR recognizes the interdependencies and interrelationships between the natural and human environments. Priorities for research reflect the holistic perspective of the whole farm/rural household and the natural and human environments.

Research on a sub-system can be considered part of the FSR process if the connections with other sub-systems are recognized and accounted for and farming systems research is evaluated in terms of individual sub-systems and the farming system as a whole.

Main Categories of FSR

Simmonds identified three categories of FSR :

(1) FSR sensu-stricto, (2) on-farm research with a farming systems perspective (OFR/FSP) and (3) new farming systems development (NFSD).

FSR sensu stricto is the study of farming systems per se, as they exist. Typically, the analysis goes deep (technically and socio-economically) and the object is more academic or scholarly rather than practical; the view taken is nominally 'holistic' and numerical system modeling is a fairly natural outcome if a 'holistic' approach is claimed.

On-farm research with farming systems perspective (OFR/FSP) is a practical adjunct to agricultural research which starts from the precept that only farmer-experience can reveal to the researcher what farmers really need. Typically, the OFR/FSP process isolates a sub-system of the whole farm, studies it in just sufficient depth (no more) to gain the necessary farming systems perspective and proceeds as quickly as possible to experiment on-farm with farmers' collaboration. There is an implicit assumption that stepwise change in an economically favourable direction is possible and worth seeking.

New farming systems development (NFSD) starts with the view point that many tropical farming systems are already so stressed that radical restructuring rather than stepwise change is necessary; the invention, testing and exploitation of new systems is therefore the object. While OFR/FSP seeks to adapt the technology to the farmers' economics, NFSD must usually imply government intervention and the adaptation of economics to technology.

Characteristics of FSR

The following are the characteristics (adapted from Sands)

It is farmer-oriented

FSR targets small-farmers as the clients of agricultural research and technology development. Consequently, its basic objective is to make technology generation more relevant to their goals, needs, and priorities. Several mechanisms are commonly employed in the approach to attain this objective. Farmers are integrated into the research process. The existing farming system is studied before proposing improved technologies. Social scientists collaborate with technical scientists on the analysis of the existing system, problem diagnosis and development of alternative technologies.

It is systems-oriented

It views the whole farm and farm household and the interrelationships and interactions between farm enterprises. This is necessary for understanding the complexity and functioning of small-farm agriculture and for the diagnosis of farm crop production problems. Enterprise interactions are considered when planning and evaluating trials.

It is problems-solving approach

FSR is essentially operational research which first identifies technical, biological, and socio-economic constraints at the farm-level for major types of farming systems. It then endeavors to develop technologies, which are feasible for the targeted farming households to adopt, meant to alleviate those constraints. The research process is both iterative and dynamic with adjustments being made in technology design as understanding of and communication with small farmers develop.

Interdisciplinary and multidisciplinary

By nature, FSR cuts across traditional commodity and disciplinary boundaries. Collaboration among agricultural scientists of various disciplines and social scientists is needed to understand the conditions under which small-farmers operate, to accurately diagnose constraints, and to develop improved technologies suitable to those conditions.

Each national program should determine the composition of its FSR team in the research site. Generally it should consist of an agronomist, a socio-economist, and local agriculturists. They are backed up by local extension personnel and by biological and social scientists from the region or a nearby experiment station.

Complements, not replaces, mainstream commodity and disciplinary research

FSR draws on the body of knowledge of technologies and management strategies generated by discipline and commodity research and adapts them to the specific environments and socio-economic circumstances of targeted group of relatively homogeneous farmers. Problems found on the farm which cannot be solved by the present body of knowledge are fed back to the discipline and commodity researchers.

Test technology on-farm

On-farm experimentation establishes the context for collaboration between farmers and researchers and fosters a deeper understanding of the farming system among researchers. It also provides for true evaluation of technologies under the environmental conditions in which it will be used.

Provides feedback from farmers

FSR channels feedback on farmers' goals, needs, priorities, and criteria for evaluating technologies to station-based agricultural researchers and to national and regional policy makers. Farmers give opinions on proposed new technology and help plan on-farm trials. Farmers themselves implement trials under the supervision of site staff. They express their opinions on the result of the trials and suggest changes. Farmers reaction and adaptations are also closely monitored during pilot production programs.

Table 1. Typical Contrasts in Physical Conditions
(Not all apply all the time, but most apply most of the time)

	Research experiment station	Resource-rice farm (RRF)	Resource-poor farm (RPF)
Topography	Flat or sometimes terraced	Flat or sometimes terraced	Often undulating and sloping
Soils	Deep, fertile no constraints	Deep, fertile no constraints	Shallow, infertile often severe constraints
Macro and micro-nutrient deficiency	Rare, remediable	Occasional	Quite common
Plot size & nature	Large, Square Small bunds	Large, Small bunds	Small, Irregular Bunds larger where present
Hazards	Nil or few	Few, usually controllable	More common-floods, droughts, animals, grazing crops, etc.
Irrigation	Usually	Usually available	Often non-existent
Size of management unit	Large, contiguous	Large or medium, contiguous	Small, often scattered and fragmented
Diseases, pests,	Controlled	Controlled	Crops vulnerable to infestation

Table 1 and 2 have been slightly modified in the light of the comparison of experiment stations and farmers' fields in Catling p. 11. Table 1 refers especially to South Asian Conditions.

Source : Robert Chambers, and B.P. Childyal. Agricultural Research for Resource-Poor Farmers : The Farmer-First-and-Last Model. Agricultural Administration 20 (1985).

Table 2. Typical Contrasts in Social and Economic Conditions.
(Not all apply all the time, but most apply most of the time)

	Research experiment station	RRF family	RPF family
Access to seeds, fertilizers, pesticides & other purchased inputs.	Unlimited, reliable	High, reliable	Low, unreliable
Needs used	High quality	Purchased high quality	Own seed
Access to credit when needed	Unlimited	Good access	Poor access and seasonal shortages of cash when most needed.
Irrigation, where facilities exist	Fully controlled by research station	Controlled by farmer or by others on whom he can rely	Controlled by others, less reliable
Labour	Unlimited, no constraints	Hired, few constraints	Family, constraining at seasonal peaks
Prices	Irrelevant	Lower than RPF for inputs	Higher than RRF for inputs
		Higher than RPF for outputs	Lower than RRF for outputs
Priority for food production	Neutral	Low	High

Source : Robert Chambers, and B.P. Childyal. Agricultural Research for Resource-Poor Farmers : The Farmer-First-and-Last Model. Agricultural Administration 20 (1985).

Table 3. Classification of Farming System Interactions

Type of Interaction	Examples
1. Biological interactions between crops	
a) Biological interactions in space.	i) Intercropping.
b) Biological interactions overtime.	i) Conflicts in planting a crop in relation to harvest or previous crop.
	ii) Carry-over of soil structure and crop residues from preceding crop.
	iii) Carry-over fertility from previous crops.
	iv) Carry-over and build-up of weed seeds and other pest populations from previous crops.
2. Biological interactions between crops and livestock	i) Use of crops and crop residues for folder.
	ii) Use of farm yard manure as crop nutrient source.
	iii) Use of animals for draught power.
3. Resource competition and complementarity	i) Conflicts in labour use between enterprises.
	ii) Cash flows from sale of one product for purchase of input for another enterprise.
	iii) Competition for irrigation water between enterprises.
4. Meeting multiple objectives of farm-households	i) Choice of multiple crops and production practices to manage risk.
	ii) Planting and storage of food crops to balance seasonal food needs.

Source : Derek, Bherlee, et.al., September 1985. Developing Crop Technologies Within the Context of Multiple Cropping Systems of South Asia. Paper prepared for the International Conference on Multiple Cropping Systems Research, Nanjing, China, October 8-12, 1985.

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FARMING SYSTEMS RESEARCH AND DEVELOPMENT APPROACH IN THE CONTEXT OF BANGLADESH - A HISTORICAL PERSPECTIVE

Dr. Nizam Uddin Ahmed

What is Farming Systems Research and Development (FSR & D) Approach ?

FSR & D approach is the one that -

- Views the whole farm as a system. A farm system can be viewed conceptually as a set of spatially definable areas in which either crops, animals or both are produced, and a homestead area where the farm house is located.

- Focuses on (1) the interdependencies between the components under the control of members of the farm household and (2) how those components interact with the physical, biological, and socio-economic factors not under the household's control.

Farming system is defined as an unique and reasonably stable arrangement of farming enterprises that the household manages according to well defined practices in response to the physical, biological and socio-economic environments and in accordance with the household's goals, preferences and resources.

In the 1970s, the term " Farming Systems" was applied to several different activities being developed around the world. But all of those activities had the following things in common :

1. A concern for the improvement of the small scale family farms.

2. Recognition that through understanding of the farmers' situation is critical for their improvement, and

3. Multidisciplinary approach is a must.

In the 1980's as the term FSR came into more common use, it became evident that two basic components, when used together comprise the FSR & D. Those two components are Farming Systems Research and Extension (FSR/E), and the Farming Systems Approach to Infrastructural support and policy (FSIP).

FSR/E is applied, farmer oriented, agro-biological research supported by socio-economic sciences in a team effort which includes extension responsibilities. The principal product is technology. The primary clients are farmers. FSR/E is more "micro" in scope and deals mostly with conditions inside the farm gate.

FSIP is applied, farmer oriented, socio-economic research, supported by the agro-biological sciences in a team effort. The principal product is information. The primary clients are policy makers and managers of services and infrastructure. FSIP is more "Macro" than FSR/E.

Why FSR & D approach ?

The organizational frame work for agricultural research and development (R & D) which has evolved over the past century, into the 1970's has worked reasonably well for the developed countries but did not work well for the developing nations. As a results a search for new agricultural R & D models continued. The European colonial model, the first one other wise known as the "Vertical model" (Fig. 1) was in existence before World War II in the African and Asian colonies. The model was based primarily upon large scale plantations devoted to production of crops for export and particularly for export to the mother country. The structure of the European model in its initial conception and supporting Philosophy was distinctly "vertical". Research was carried out in the laboratories and sent "down" to the plantation, where production could be closely supervised and controlled, as in a traditional industrial organization. Any feedback was definitely "upwards" to the scientist who guided the operation. Naturally, adapting this model for work with small farmers proved difficult.

The second model of agricultural R & D was developed after 1945 through the United states technical and financial assistance in Latin America and Middle Eastern and Asian countries which is other wise known as the "Horizontal model" (Fig. 2).

This model gained tremendous popularity in the western countries and was found very effective. Many U. S. experts assumed that this model would result in the same increase in productivity and farmer income as had occurred in the United States. But unfortunately, for many reasons it did not work in that way. This U. S. model resembled the European model by having essentially a one way flow initiatives and information.

Following the European and the U. S. models of Agricultural R & D, then came the FSR & D model (Fig. 3) in the 1980's. Because of the particular* for the small farms, this has so far been found very effective in the under developed or the developing countries. In this model, since extension workers, researchers and farmers all work together, flow of information and initiatives does not get blocked in any phase, rather works very dynamically.

How FSR&D started in Bangladesh ?

In Bangladesh, cropping systems activities as being a major component of farming systems started first in 1976 at the Bangladesh Rice Research Institute (BRRI). From there, over time it gradually spread in other sister organizations. In early 1980's the Bangladesh Agricultural Research Council (BARC) formed national coordinated cropping systems net work by invloving several agricultural research institutes and the Bangladesh Agricultural University to strengthen the R & D activities in cropping systems. Few years later, this network has been renamed as the national coordinated farming systems network and more thrust has been given to acclerate the R & D process of not only the crops but also the other farm enterprises egg. livestocks, fisheries, agroforestry, gender issues etc.

So long except in two research institutes (namely BRRI and BARI) the farming systems program has not been institutionalized. In other words, in rest of the institutes/organizations, farming systems R & D is still continuing with external fund support. However, it is expected that in the near future all the institutes/organizations involved in FSR & D would be able to institutionalize the program and there by would be able to strengthen further their FSR & D effort.

* Characteristics of this model and it's concern.

<u>Characteristics of FSR & D Approach</u>

The FSR & D can be summarized as being :

1. Farmer-based, because FSR & D teams pay attention to farmers' conditions and integrate farmers into the research and development process.

2. Problem solving, because FSR & D teams seek researchable problems and opportunities to guide research and to identity ways for making local services and national policies more attend to the farmers' needs.

3. Comprehensive, because the FSR & D teams considers the whole farm as an unit for development.

4. Interdisciplinary, because researchers and extension staff with different disciplinary backgrounds work together.

5. Complementary, because it offers a means for using the outputs of other R & D organizations and for giving direction to other work.

6. Iterative, because FSR & D teams use the results from research to improve their understanding of the system and to design subsequent research and implementation approaches.

7. Dynamic, because it is always changing towards improvement and not static, and

8. Responsible to society, because FSR & D team keeps to the interest of the general public.

<u>Importance of FSR & D approach for strategic planning and sustainability</u> :

Because of the nature and characteristics of the FSR & D approach, it has been found very much effective so far in solving the problems of small scale family farms in many Asian, African and Latin American countries. In FSR & D approach, farmers plays a vital role in research planning, and development by being involved in it along with their research counterparts, which is not possible in any other R & D process. This results in increasing the effectiveness of the system and increases the sustainability both in terms of farmers participation and increased production.

<u>Programme areas of FSR & D</u> :

Following are the program areas or components of FSR & D currently in practice in Bangladesh.

1. Crops
2. Livestock
3. Fisheries
4. Apiculture
5. Agro-forestry
6. Womens issues
7. Socio-economic and
8. Non-farm enterprise.

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/--------------------------------------\
|    Scientific Research Center        |
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                 |    |
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        /-----------------------\
        |         Staff         |
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                 |    |
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                 |    |
  /-----------------------------------------------\
  |        Plantation or field operations         |
  \-----------------------------------------------/
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Figure 1 : The "Vertical" Model of Agricultural Research & Dev.

```
/-------------------------\      /-------------\      /----------\
|    University           |---->| Extension    |---->| Farmers   |
|    Research Programs    |<----| Service      |<----|           |
\-------------------------/      \-------------/      \----------/
                                                          |   |
                                                   /------/   |
                  /-----------------\              |   /------/
                  |   Supporting    | <-/          |
                  |   Services      | <------------/
                  \-----------------/
```

Figure 2 : "Horizontal" Model of Agricultural R & D.

```
    /---------------\           /-------------------\
    |   Research    | <------>|     Extension       |
    |               | <------>|                     |
    \---------------/           \-------------------/
       |      |                            |    |
       |      |                            |    |
       |      |     /----------------\     |    |
       |      \--->|     Farmer       | <-/     |
       \---------->|                  | <-------/
                    \----------------/
```

Figure 3 : The "FSR & D" Model of Agricultural R & D.
Legend : Strong flow : ---------
Week flow : ---------

SHIFTING TOWARDS A MORE COMPREHENSIVE FARMING SYSTEMS APPROACH IN BANGLADESH

Dr. R. N. Mallick

A B S T R A C T

Component technology research in farmers' fields was initiated in the late 1950s by the soil fertility programme. Rice based cropping systems research (CSR) began in 1974. In 1979 the national coordinated cropping systems research programme was started with the participation of nine organizations. Emphasis was on the study of cropping systems in the farming unit. More than 90 cropping patterns with associated available technologies were tested, adjusted and modified in 28 different agro-socio-economic environments in 15 districts. Sixteen cropping patterns with associated technologies have been recommended for multilocation testing in different environments. These patterns have the potential to increase yield from 11% to 166% and net income from 20% to 188%. Crops contribute 37%, livestock 7%, fisheries 1% and forestry 3% of total gross domestic product. In 1983, the Bangladesh Government especially emphasized a more comprehensive farming systems approach to include the other components of the farming unit, such as livestock, fisheries and agroforestry. A series of discussion meetings and workshops was conducted by top-level planners and executives and field-level

Scientists during 1983-84. The farming systems approach will be followed in 16 farming systems research (FSR) sites throughout the country. To begin with the FSR thrust may be on only one component of the farming unit, depending upon the priority given to the problem needed to be solved after exploratory and/or diagnostic survey. In all cases socio-economic studies will be an essential part of the research plan. A series or training courses on farming systems research methodology is mudr way to achieve the goal.

INTRODUCTION

During the past two decades demand for food has risen faster than increase in production. This has resulted in low per capital food output in Bangladesh. Since the majority of Bangladeshis is depend upon their own farm production for their livelihood. A single farm produces several crops in order to be as nearly self-sufficient as possible, farmers do not devote large areas to a single crop. The cropping intensity of the country was 154%. Single cropping is followed in 54%, double cropping 38% and triple cropping in 8% of the net area (SYB 1984). Bangladesh agriculture operates primarily a subsistence system. Only a small proportion of the farm output moves in to the market. It is not common for two fields lying side by side to be cropped differently depending upon availability of family

labour and draft animals and risk. The high-yield technology package developed by on-station research could not be adopted by the farmers to the extent expected. So the yield gap of different crops is almost double between research stations and farmers' fields.

Bangladesh forms the largest delta in the world and is situated approximately between 20.70° and 26.80° north latitude and 88.01° and 92.70° east longitude. The topography is divided into five categories, namely highland, medium land, lowland, very lowland and highly land (AYB, 1982).

Highland - The area is relatively high and cannot hold water during the monsoon. Some water is retained by raising alleys or-embankments around fields.

Medium - The land is uniform by flat-faced. Water movement can be controlled with the help of alleys.

Lowland - Monsoon water stands in the land more than one metre deep and may reach nine metres. Water movement cannot be controlled.

Very lowland - The land consists of haors, beels, canals and other low lying areas, and during the rainy season looks like large lakes. Depth of water may become as much as nine metres. In winter, the water drys up except in the centre

RESEARCH IN FARMERS' FIELDS

Component technology research in farmers, fields was initiated in late 1950 in a soil fertility project. Rice-based cropping systems research (CSR) was initiated in 1974 by the Bangladesh Rice Research Institute (BRRI) with the active participation of farmers using methodology developed by the Asian Cropping Systems Network of the International Rice Research Institute (IRRI). National Coordinated Cropping Systems Research (NCCSR) was undertaken.

* Haors large confined permanent, naturally occurring bodies of water, excluding rivers.

* Explanatory footnote appropriate.

In 1979 under the leadership of the Bangladesh Agricultural Research Council (BARC) with the participation of the Bangladesh Agricultural Research Institute (BARI), Bangladesh Jute Research Institute (BJRI), Bangladesh Agricultural University (BAU), Sugarcane Research and Training Institute (SRTI) and Bangladesh Water Development Board (BWDB). Non-government organization such as Cristian Reformed World Resief Committee (CRWRC), Health Education and Economic Development (HEED), National Christian

Committee of Bangladesh (NCCB) and Mennonite Central Committee (MCC) also initiated cropping systems research in their working areas (Table-1). The mandate of NCCSR was for a national system of cropping systems research in farmers' fields.

METHODOLOGY

The methodology used was site selection, site description, classification of environment, design of improved cropping systems, which include component technology studies, and cropping pattern testing, and their testing individual farms followed by multilocation testing and production programmes. The programme was oriented towards testing, adjusting and modifying the existing technology with farmers' participation in farmers' fields.

The programme of NCCSR was oriented towards (1) testing, adjusting and modifying existing agricultural technology in the country with farmers' participation, (2) conducting research on a cropping pattern design to evaluation the interaction between different crops, (3) combining the agronomic and socio-economic components to get a better understanding of existing farming practices, and (4) developing systems for technology transfer through a better linkage between research and extension.

CSR Site Description

During 1979 the required benchmark information on all components of the farming unit was not available so research was started only on the cropping systems component. Nine organizations established 28 cropping systems research sites in 15 districts, conducting research on cropping pattern performance to evaluate the interaction between different crops and to understand existing farming practices in different agro-ecological conditions of the country (Table-1).

Benchmark surveys were conducted, six to ten predominant and alternative cropping patterns with associated available component technology were tested for two to three years on each CSR site. The plot size was 500-1000 m2 for cropping pattern testing and 15-50 m2 for component technology study with five farmer participants for each pattern in similar land type. The Department of Agricultural Extension (DAE) and the Department of Soil Survey were actively involved in site selection, soil identification and designing and testing of cropping patterns.

The annual rainfall of the sites varied from 1426 mm to 4280 mm. The maximum mean monthly temperature was from 30°C to 33°C and the minimum from 20°C to 21°C. The land types were highland to lowland. The average family size was from five to nine and farm size was from 0.27 ha to 1.47 ha (Table-1).

Cropping Pattern Testing

More than 90 cropping patterns with associated available component technologies were tested, adjusted and modified and compared with similar farmers' cropping patterns. The improvements were made by introducing changes in crop variety, fertilizer doses, seed rate, minimizing the turn around period and other management practices for increasing the yield of each crop, and increasing cropping intensity by changing components in the cropping patterns (Table-2).

FARMING SYSTEMS APPROACH

Besides growing crops, Bangladesh farmers raise cattle for draft and milk purposes and poultry for meat and eggs. They utilize the homestead area for a variety of purposes including post-harvest processing of agricultural crops. If the farmer has a little pond, he raises fish as well. These activities and others are closely interlinked and nutually dependent. The turn-around time between two crops and the number and quality of tillage operations are dependent on bullock availability. On the other hand the number of bullocks one may support and maintain the health is dependent on the availability of fodder. Proceeds from the sale of poultry examples could be provided to illustrate the linkage existing among different enterprises of the Bangladesh farmers.

These interlinking production and consumption systems of the farmer suggest that technologies generated in Bangladesh must be in the context of the farmers' total activities. Such realization inside the country as well as developments elsewhere in the world led the practitioners of FSR & D and other national leaders in Bangladesh to reorient the on-farm research into a farming systems research approach.

The increased yield and cropping intensity beyond threshold limits demands higher inputs in the form of draft energy, manures fertilizers, labour and capital. Some of these can be met through improvement of a interaction between non-crop components of the farm enterprises, namely livestock, poultry, fisheries, homestead gardening, agroforestry and off-farm activities.

FSR Approach Thrust

In 1983 the Bangladesh Government gave emphasis to a more comprehensive farming systems research approach and to include other component. A series of discussion meetings and workshops were conducted by top-level planners and executives and field-level scientists during 1984-85. To begin with, the FSR thrust on a site may be on only one component of the farming unit, depending upon the priority of the problem after exploratory and diagnostic survey. Farmers will be considered as the central

focal point rather than passive participants. The crop component will continue to dominant the research programme in the FSR approach as crops contribute 36.8% to the GDP while livestock contibutes 6.5% fisheries 3.6% and forestry 3.1% (SYB 1974). Inclusion of other components will depend on evaluate scientific manpower, physical and economic resources and priorities fixed by government policy makers. Socio-economic studies will have high priority. At present only five sites have a full-time economist. Activities on present sites have been revised and additional sites will be selected.

A national co-ordinated farming systems research project is being prepared with the participation of seven institutions and involving 26 sites. BLRI two (Table-1). FSR project areas in which the cropping systems have been studied will receive priority to avoid dublication and shorten the research period. The study of the crop subsystems will continue. Key informant or sondew studies which provide information quickly will be followed.

The main considerations in designing cropping systems research were land type and climatic elements. The farmers were also considered as one of the determinants, being classified by their land holdings. While surplus resources available at the time it is required and income-expenditure balance of the family is more vital in making decisions in the acceptance or rejection of a technology. Identifying the client group by landholding is not practicable because land productivity differs from area to area. Man-land ration per family affects resource availability, as do income from other sources and the kinds of cropping. In the new approach, the client group will be categorized as resource-rich or resource-poor farmers, or agricultural labourers. Technologies will be designed for the different farm categories and different parameters will be used to evaluate the technologies for recommendation. Ex-ante analysis will be done to choose the alternatives. Of course it irrespective of categories.

Farmers' involvement in designing technology will be achieved by seeding their opinion as to the solution of a problem at the planning stage. Setting specific objectives for individual sites is being given top consideration; thus farms in the rainfed Barind area and those in saline areas will have different objectives.

The fertilizer doses used in the cropping patterns were based on monocrops with no consideration given to the residual effects of nutrients. Now the effects on cropping patterns of applying a full dose of fertilizer to the winter crops and the reserve residual effects on summer crops are under study. Fertilizer doses are developed for the whole pattern.

Generally land under cultivation is divided into several parcels, only one or two of which are used for cropping pattern testing. Now however all the parcels belonging to selected farmers will be used for testing different cropping pattern to

see if the farmers' resource endowments allow them to follow the alternatives. The farmers' homestead, livestock, poultry, fish-cum-duck culture and on-farm forestry will also be taken into consideration depending upon the need and available technology.

The crops components of the designed patterns are strictly followed for planting. Due to uncertainty of rainfall and the other reasons the planting time delays on the planned crop is not profitable as the price of other crop has increased so depending on the situation the crop component will be changed and reasons will be identified.

Certain components of the pattern may have high potential for improvement. These may be identified during the cropping season and incorporated in research. For example, if sulphur deficiency is found in a rice crop on an FS site and there is no previous plan for doing research, then sulphur may be applied in 20 to 30 farmers' fields and the results will be recorded.

Winter maize gives 6% MT/ha grain yield at research stations but maize has not been adopted by the farmers due to their unfamiliarity with it for home consumption or due to marketing problems. This type of crop will be introduced along with others including sunflower.

Multilocation Testing

Multilocation testing of recommended cropping patterns was initiated by BRRI in 1982. Based on the agro-climatic situation of CSR site Bogra, five multilocation sites were selected in five districts. In each test location six farmers were selected with 1000 m2 to test T. Aus rice (MV) T.Aman rice (MV) cropping pattern instead of B.Aus rice (L) - T.Aman rice (L). Six non-participant farmers were monitored for comparison. The results indicated that 7-10 ML/ha per year can be obtained with modern technology which was 50-300% higher than the existing farmers' pattern. This pattern testing was expanded to 14 locations in 1983 and 26 locations in 1984. T.Aman (MV) - Boro (MV) cropping pattern was recommended by BRRI for MLT in 13 locations in 1984. In 1985-86 BARI is organizing a multilocation testing programme in 83 locations. While BJRI plans 10, BAU 10, SRTI 12 and MCC 90, (Table-2).

Pilot Production Program

Based upon the findings and experience at Bogra and the MLT sites a pilot production programme was launched in 1983 at Joydebpur and Sylhet by BRRI. Fifty plots blocks with 19-27 farmers were selected. Cropping pattern with rice (BR-1) - rice (BR-11) production 1 ML/ha more grain yield at Joydebpur and 5 ML/ha more at Khadimnagar Sylhet over farmers' pattern. It

costed US $ 180/ha extra and gave US $/ha 774/ha productional benefit. The pilot production grogram was expanded to three districts by BRRI, three by BARI, one by BAU and one by BJRI in 1985-86.

Adoption

An adoption study was conducted in 1982 in Bogra and CSR was initiated in 1986. The rate of adoption of the rainfed modern variety (MV) double rice cropping pattern technology was higher within the CSR project area. More than 95% of the farmers in the study area grow a modern transplanted aus rice crop (BR-1) or (BR-3) in the first season. The rate of adoption decreased with the distance from the original site. Acceleration of diffusion of the technology could be achieved by more aggressive extension and institutional support (Hossain at al 1984). A single lean form to cover both the aus and aman credit was necessary. A good relationship with fertilizer dealer, pesticide dealer and bank are needed for the smooth supply of inputs. Unawareness of technology, high price of inputs and late rainfall were the major constraints.

Evaluation Criteria

Criteria for judging technologies for different client groups will be specified. Yield advantage, turn around time, additional cash cost involvement, additional labour requirement and net benefits will be foremost in deciding whether to recommend a technology.

LIVESTOCK COMPONENT IN FSR APPROACH

Cows, bullocks and water buffalo are next to crops in importance. A non-comprehensive list of livestock measurements can be taken at the FSR level to measure the productive success of each practices in terms of partial budgeting of additional farmers inputs versus additional farmers outputs. Effect of alternative cropping systems technologies on large animals will be estimated. Slow change in cropping systems influences animal numbers, draft power, yield of animal by-products and type of animals chosen.

The following points were considered :

1. Initial inventory of all animals by species, sex, age (by teething and owner estimate) weight (by spring scale or tape), height, flesh condition, health, reproductive stage, reproduction history (as possible), survival record of previous offspring, lactation stage, draft load in type and days (hrs) and length of location.

2. Collection of milk yield, egg production, chick production, young animal gains, animal product sales, consumption and price.

3. Quantity of fodder and feed both from home production and purchase with price for each type and sources of feed.

4. Labour used for feeding, watering, grazing, working, etc.

5. Record hours and days of work in owners' fields and for rental (cultivation, threshing and transport)

6. Prices of all inputs and outputs.

7. Repeat inventory with weight and height measurements quarterly.

8. Repeat collection of yield gains, sale and consumption monthly.

9. Record death treatment data.

10. Record death and mortality dates and causes as best known.

11. Record amount of waste or loss from storage and feeding of created and untreated straw.

12. Measure length, weight and number of fish from manure-fed versus non manure-fed ponds.

Introduced FSR Practices to be Compared to Status Quo

1. Balanced ration for cattle, buffalo and/or goats/sheep (Grow or purchase legume hay for supplement drying lactation and/or draft).

2. Use of cows for draft with seasonal breeding to avoid season of heavy work during late pregancy and lactation.

3. Single bullock with improved harness for small-low and lighter work.

4. Feeding cull cattle for special market of holiday sacrifice.

5. To follow the recommended vaccination schedule for cattle, buffalo, goats/sheep and/or poultry.

6. To follow the recommended internal parasite treatment for cattle, buffalo, goats/sheep and/or poultry.

7. Straw treatment with urea in baskets, plastic bags and/or stacks to test both value for storage and value as measured by performance of animals consuming the feed.

8. Relay of legume or maize crop to minimize tillage for food grain and for forage to feed directly or after storage.

9. Milk goats for fresh milk and/or cheese.

10. To build poultry rooster over fish pond to supplement fish diet.

11. To Grow or to purchase green forage from waste and/or forest land to balance rations of milk cows, draft animals and/or to feed cull cattle for holiday sacrifice.

12. To feed draft bullocks for maximum performance for owners' draft and rental.

Homestead Production Systems

The homestead of a farmer in Bangladesh is a multipurpose production and utilization centre. Cattle, poultry, goats, a few plants of different cucurbits, other vegetables, trees for multiple use are raised in different combinations on and around the homestead. These production activities are almost exclusively looked after by the womenfolk but have tremendous impact on family income and expenditure. The aspect will be carefully studied. Alternatives will be tested putting emphasis on family nutrition, small cash earnings throughout the year, family fuel needs and employment of the women labour force at the family level.

FISHERY COMPONENTS IN FSR APPROACH

Ponds and haors * contribute 3% of the water resources for inland fish production. The following research programme on farming systems was proposed :

1. Improvement of fish culture techniques in ponds.

2. Proper use of water for agriculture and aquaculture.

3. Integrating farming fisheries, horticulture and livestock.

4. Improvement of fish culture technique in paddy fields.

5. Use of the harvested rice field as a nursing ground for carp spawn.

AGRO-FORESTRY COMPONENT IN FSR APPROACH

Forests occupy about 8% of the land area and forest products make up about 5 percent of the total value of all agricultural products :

Approximately 70% of wood and 90% of fuel wood and bamboo come from rural homesteads. Agro-forestry can be developed from two directions :

1. Introduction inter-cropping in designated forest areas.

2. Introducing woody perennials into the existing farming systems site.

   a) Village tree cultivation.

   b) Tank bunds.

   c) Waste land, Khas land, road and railway verges, and coastal embankments.

Agro-forestry practices were first introducted in the Chittagong Hill Tracts and in Chittagong District during 1977-78.

The following studies on agro-forestry may be included in farming systems research :

a) Bench mark survey on homestead production by homestead size and income groups.

b) Sociological research to determine farmer and local community perception of the usefulness of trees, their views on such critical matters as choice of species and their willingness to co-operate with Government in management and production of forest.

c) Identification of high yielding and fast growing fuel wood species and other multiple use crops for on-farm trials.

d) Identification of light-demanding and shade-tolerant agricultural, horticultural, forage and medicinal plants for intercropping with tree spacies in plantation both on Government forest land and on marginal and waste land.

e) Research on the development of multistoried forest with multiple use species for timber fuel, fodder, food and medicinal plants.

f) Development of techniques for maximizing sustainable production of tree fodder and fuelwood using such techniques as branchwood, looping, pollarding, coppicing and hedgerow management.

g) Studies on agricultural, horticultural and forest tree crop mixtures.

Training

A training course has been designed for FSR researchers and Subject Matter Officer (SMO) of the Department of Agriculture.

Seventy-five research scientists who will be directly responsible for day to FSR field work will be trained. Around 200 field level junior workers were trained to assist in the day to day research at the FSR and multilocation testing sites. There is an excellent network of multilocation testing sites representing almost all environments in the country.

Co-ordination

FSR will be co-ordinated by an Executive Committee under the chairmanship of the Minister for Agriculture and a National Farming Systems Technical Committee under chairmanship of BARC. Heads and senior FSR scientists of the various research institutions are members of the National Technical Committee.

SUGGESTED ACTIVITIES TO BE IMPLEMENTED WITH A FARMING SYSTEMS RESEARCH APPROACH

1. Exploratory surveys

Collection of information to understand existing farming systems, innovation problems and constraints faced in farming, post harvest operations, livestock, fish production and farm forestry.

2. Site description surveys

Collection of information on existing socio-economic and agro-ecological information. The survey systems of differs to define different client groups, and their characteristics.

3. Special purpose surveys

Collection of information on specific issues that need further detailed analysis : adoption survey, monitoring surveys, agronomic surveys, livestock surveys, off-farm employment surveys, etc. Sample design and survey instruments will be decided depending on the purpose of the survey.

4. Description of operating farming systems in the selected area. Selection of 45 representative farms in the site to carry out "whole farm" studies. The output will be a description of how different farming units are operating.

4.1 Preparation of technical paper for presentation in Agriculture Economic and Social Science Survey workshop series.

4.2 Preparation of paper for other seminars or workshops.

5.0 Agro-socio-economic studies.

5.1 Cropping pattern testing.

5.1.1 Evaluation of the performance of existing predominant cropping patterns under farmers' management (FO).

5.1.2 Evaluation of the performance of existing predominant cropping patterns under improved agronomic practices (FI).

5.1.3 Evaluation of 6-10 cropping patterns including crops different from those normally grown by farmers.

5.2 Component technology studies.

5.2.1 Crops.

5.2.1.1 Variety trials of promising lines of different crops.

5.2.1.2 Evaluation of crop varieties under intercropping or mixed cropping conditions.

5.2.1.3 Soil moisture depletion in cropped areas. Determination of seasonal changes in soil moisture content under different cropping patterns and in different land types.

5.2.1.4 Soil and soil moisture conservation practices.

5.2.1.5 Effective use of rainfall.

5.2.1.6 Supplementary irrigation study for T.Aman rice.

5.2.1.7 Fodder crop production at turn-around time.

5.2.1.8 Cropping pattern performance in irrigated lands.

5.2.1.9 Practical tools and indicators for irrigation scheduling for farmers.

5.2.1.10 Block irrigation assessment for rice-based irrigation systems.

5.2.1.11 Water quality monitoring in selected sites.

5.2.1.12 Irrigation and drainage needs of salt-affected coastal area farms.

5.2.1.13 Farming activity monitoring as a management (decision-making) tool.

5.2.1.14 Operation and maintenance practices for the water source sub-system.

5.2.1.15 Improving the irrigation delivery systems.

5.2.1.16 Re-design of small land holders' irrigation systems.

5.2.1.17 Ponds for fish, domestic water supply and supplemental irrigation.

5.2.1.18 Bamboo tubewells and use of human and animal driven pumps.

5.2.1.19 Promotion of border and furrow irrigation of diversified crops.

5.2.1.20 Surge flow irrigation for improved irrigation efficiency.

5.2.1.21 Mannual pumps.
comparison of different types of manual pumps under selected cropping patterns.

5.2.1.22 power pumps.

5.2.1.23 Operation and maintenance of power pumps.

5.2.1.24 Special purpose survey.

5.2.1.25 Special study on spare parts of irrigation equipment.

6.1 Evaluation of existing livestock system annually.

6.2 Improvement of nutrition and draft animal efficiency (on FSR site). Balanced rations for bullocks and draft cows to increase draft and production efficiency with legume hay and/or maize tops and green fodder.

6.3 Improvement of animal health. Disease and internal parasite. Control for foats, chickens, and ducks.

6.4 Improvement in animal nutrition and draft animal efficiency (on-station). Comparison of single versus double bullock draft efficiency under low and moderate nutritional conditions (on-station research).

7.0 Socio-economic evaluation of agro-forestry systems.

7.1 Comparison of agro-forestry production systems.

7.1.1 Evaluation of the performance of the existing agro-forestry systems (AFS-F).

7.1.2 Evaluation of the performance of existing agro-forestry systems under improved practices (AFS-FI).

7.1.3 Evaluation of the performance of alternative agro-forestry systems (AFS-FA).

7.2 Component technology studies.

7.2.1 Management practices of fodder trees.

7.2.2 Management practices of multipurpose use (fodder-fuel-wind barrier) trees.

7.2.3 Improving management practices of fruit trees (mango, jack fruit, citrus).

7.2.4 Potential and methods for replacing local with improved tree species. (including fruit trees).

7.2.5 Others.

8.Ø Socio-economic evaluation of homestead production.

8.1 Exploratory survey.

8.2 Comparison of homestead production systems.

8.2.1 Socio-economic evaluation of the existing homestead production systems (HPS-F).

8.2.2 Socio-economic evaluation of existing homestead production systems under improved practices. (HPS-FI).

8.2.3 Socio-economic evaluation of alternative homestead production systems (HPS-FA).

8.3 Component technology studies.

8.3.1 Studies of methods for benefiting from crop by-products.

8.3.2 Evaluation of methods fo grain storage (rice, wheat, mustard etc.) for seed and human and animal consumption.

8.3.3 Evaluation of methods for storage of tuber and root crops for seed or for human or animal consumption.

8.3.4 Study of methods to improve nutrient recycling (cowdung and uringe collection).

8.3.5 Study of tree crops and animal by-products as source of energy.

8.3.6 The role of women in household development and its economics.

Table 1 : Cropping systems research sites, their year of initiation, soil texture, organization, farm location and rainfall, Bangladesh 1985.

A. No	Cropping Systems Research site	Year of Initiation	Soil Texture	Organi-zation	Farm size (ha)	District	Rain fall mm
1.	Bhogra * (R)	1976	CL	BARI	1.75	Dhaka	2098
2.	Salna * (1)	1976	CL	BARI	1.47	Dhaka	2098
3.	Laskarchala * (1)	1976	CL, SCL	BARI	1.74	Dhaka	2098
4.	Jarunbari * (1)	1977	CL	BARI	-	Dhaka	2098
5.	Daudkandi * R & I	1979	-	BARI	0.9	Comilla	2117
6.	G.K. Project I	1989	-	BARI	-	Kushtia	1600
7.	Alimganj * R -	1989	C-CL	BARI	1.35	Rajshahi	1426
8.	Sreepur	+ 1985	-	BARI	-	Dhaka	2098
9.	Ishurdi R	+ 1980	S-L-C	SRTI	-	Dhaka	1588
10.	Joypurhat	+ 1985	-	BARI	-	Joypurhat	2368
11.	Thakurgaon	+ 1985	-	BARI	-	Thakurgaon	2152
12.	Trishal R & I	1980	SL,SCL,	BAU	1.07	Mymensingh	2238
13.	Bahadurpur *	1987	SL	BAU	-	Mymensingh	2238
14.	Kazirshimla	+ 1985		BAU	-	Mymensingh	2238
15.	Kishoreganj	+ 1985		BAU	-	Mymensingh	2238
16.	Kalampur R	+ 1980	CL-L	BJRI	0.4	Dhaka	2098
17.	Vaskarkhilla R & I	+ 1980	S	BJRI	0.5	Kishoreganj	2433
18.	Kanaipur R & I	+ 1983	-	BJRI	-	Faridpur	1991
19.	Paglapir	+ 1985	-	BJRI	-	Rangpur	2368
20.	Thakurgaon I *	1980	SL,CL	BWDB	1.7	Thakurgaon	2152
21.	DND I *	1970		BWDB	1.7	Dhaka	2098
22.	Nather Petua R	1980		MCC		Comilla	2117

Contd...table 1.

A. No	Cropping Systems Research site	Year of Initiation	Soil Texture	Organi-zation	Farm size (ha)	District	Rain fall mm
23.	Teuaga R	1980		MCC		Comilla	2117
24.	Charbata	1979	SCL	MCC		Noakhali	2117
25.	Hathazari R & I	+ 1980	C-SCL	BARI	0.27	Chittagong	2865
26.	Bagerpara R & I	+ 1980		BARI	1.47	Jessore	1765
27.	Laharikanda R & I	+ 1983		BARI		Jamalpur	1938
28.	Kalikapur R & I	+ 1981	SL-CL	BARI	1.32	Pabna	1588
29.	Jonakinathpur R	+ 1981	SL	BARI	1.09	Rangpur	2368
30.	Godagari R	+ 1982	C-CL	BARI	1.35	Rajshahi	1426
31.	Kahaloo R & I	+ 1981	C-CL	BARI	1.47	Bogra	1557
32.	Tangail R & I	+ 1984		BARI		Tangail	1938
33.	Serajganj I *	1985		BARI		Serajganj	1588
34.	Barisal R & I	+ 1985		BARI		Barisal	2050
35.	Kalamganj I *	1979		HEED		Sylhet	4280
36.	Gournadi *	1979	S	NCCB		Barisal	2050
37.	Anantabala * R	1980	C-CL	CRWRC	0.6	Bogra	1757
38.	Kathom * R & I	1980	C-CL	CRWRC	0.6	Bogra	1757
39.	Charkai	+ 1985		FRI		Dinajpur	2152
40.	Charatijani	+ 1985		FRI		Tangail	1983
41.	Banderban	+ 1985		FRI		Banderban	2865
42.	Salna	+ 1985		FRI		Dhaka	2098
43.	Baghabari	+ 1985		BLRI		Pabna	1588
45.	Sibganj	+ 1985		BLRI		Rajshahi	1426

R = rainfed, I = irrigated, L = loam, C = clay, + FSR approach activities initiated
BARI - 10, BJRI - 4, FRI - 4, SRTI - 3, BAU - 2, BLRI - 2, BRRI - 1, Total - 26.
* Phased out.

Table 2 : **Major component technology use in various crop in different cropping patterns.**

Crop		Variaby	Fertilizer doses N - P - K kg/ha
1.	Rice (T.Aman)	BR-11 or BR-10	80 - 60 - 40
2.	Rice (Boro)	BR-3, Pajam	80 - 60 - 40
3.	Rice (T.Aman)	BR-1, or Purbachi	80 - 60 - 40
4.	Rice (B.Aus)	Hashikalmi (L)	60 - 40 - 20
5.	Jute	CVE-3, 0-4, D-154	45 - 11 - 35
6.	Maize	Sadaf	100 - 60 - 40
7.	Potato	Cardinal	120 - 100 - 120
8.	Wheat	Sonalika (Lato) Irrig.	80 - 60 - 40
		Kanchan or Balaka (Early) Irrig.	80 - 60 - 40
		Rainfed (Var-same)	60 - 60 - 40
9.	Mustard	SS-75	60 - 60 - 30
10.	Chickpea + Barley	Local	30 - 20 - 20
11.	Sugarcane + Potato	CO-1158 or ISD 15	159 - 94 - 110
		Cardinal	95 - 63 - 68
12.	Sugarcane + Mustard	CO-1158	125 - 125 - 100
		SS-75 (Irrig.)	21 - 22 - 14
		Tori (Rainfed)	
13.	Lentil	Local	30 - 40 - 30
14.	Chilli	Local	50 - 30 - 20

Table 3 : Cropping patterns recommended as a result of testing at various CSR sites for multilocation in similar agro-ecological conditions in Bangladesh.

	Summer 11 (Aman)		Winter (Rabi)		Summer 1 (Aus)	Increase % Yield	Return
			IRRIGATED				
1.	Rice	-	Rice	-		67	51
2.	Rice	-	Mustard	-	Rice	55	92
3.	Rice	-	Wheat	-	Rice	89	110
4.	Rice	-	Potato	-	Rice	85	135
5.	Rice	-	Potato	-	Maize	160	188
			RAINFED				
1.	Rice	-	Fallow	-	Rice	46	84
2.	Rice	-	Chickpea + Barley		Rice	105	111
3.			Mustard	-	Rice	47	148
4.			Mustard	-	Jute	117	131
5.			Chilli	-	Jute	33	46
6.			Sugarcane + Potato			23	20
7.			Sugarcane + Mustard			11	27
8.			Lentil	-	Jute	36	49
9.	Rice	-	Wheat	-	Jute	35	60
10.	Rice	-	Wheat	-	Rice	94	101
11.	Rice	-	Chilli	-	Rice	31	38

National Coordinated Farming Systems Research Program, BARC 1985-89

	Scientist	Support Staff	Fund Tk. in lac	
BARC	4	4	25.00	
BARI	3	3	17.35	*
Jamalpur	1	4	18.88	
Rangpur	1	3	10.68	
Hathazari	1	4	19.73	
Kalikapur	1	4	19.06	
Jessore	3	3	19.04	
Tangail	2	3	10.67	
Patuakhali	6	10	50.25	
Bogra	1	2	9.70	
Sirajganj	1	3	10.15	*
Barisal	1	3	5.12	*
Rajshahi	2	3	11.18	
Noagaon	4	5	19.75	
Kazirshimla	4	7	22.54	
BJRI	1	6	10.11	*
Kalampur	3	4	11.03	
Vaskarkhilla	3	4	11.02	
Kanaipur	3	4	11.96	
Paglapir	2	4	11.48	*
Ishurdi	3	6	16.63	
Thakurgaon	3	5	18.22	
Joypurhat	3	4	12.82	
Sreepur	4	6	19.92	
BLRI	15	4	23.93	
Bandarban	3	6	23.94	
	78	114	435.16	

* Discontinued from January 1989.

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OVERVIEW OF FARMING SYSTEMS RESEARCH METHODOLOGY

Robert. E. Hudgens

I. INTRODUCTION

In earlier sessions of this workshop, you have been exposed to the general concept of a farming system. You now understand the need for a farming systems perspective in agricultural research to genrate relevant production technologies for the small, marginal, and landless farmers in Bangladesh. You also have seen that to fully comprehend complex farming systems it is necessary to subdivide than into parts (subsystems) and them to subdivide the parts further into functional elements (technical components).

Objectives of Farming Systems Research

It is important to keep in mind that in simplest terms the goal of Farming Systems Research (FSR) are to :

1. Understand an existing farming system.

2. Identify technical problems and production constraints affecting the farming system.

3. Prioritize these problems for field research.

4. Consider technical alternatives and management options for each priority problems.

5. Screen potential solutions to the problems identified under the farmer's production conditions.

6. Evaluate the effect of a new innovation on other aspects of the farming system.

7. Pass information on the successful innovations to extension personnel for dissemination to the wider farming community.

8. Monitor farmer adoption.

In the process of implementing FSR, a considerable amount of information is generated on the physical, biological, and socio-economic characteristics of the production environment, the interaction of subsystems, and farmers' diagnosis moves from the "whole system" to "functional components", while the study of the effect of new innovations moves in the opposite direction. In the later stages of the methodology, the adaptability of a new technology to other parts of the agro-ecological area (and eventually to the region as a wholw) is evaluated.

The purpose of this paper is to discuss how to proceed in the sequential implementation of FSR at a given site since other speakers in this workshop will be giving you much more detailed information on experimental techniques, data collection, and data analysis at each methodological stage of FSR, my intention here is simply to present a conceptual overview of the methodology to show where FSR starts, how FSR activities develop over time, and what final output can be expected.

II. FSR METHODOLOGY FLOW CHART

FSR Methodology is a step wise progression of problem identification and problem solving activities. These activities can be viewed chronologically as distinct methodological stages, each of which occurs in a spearate spatial cimension (Fig. 1).

Spatial Dimension

In order to attain a genral understanding of the farming systems in a region and to identify the major production problems that can be addressed through research, a systems analysis is undertaken, moving form a description of the "regional situation" to a description of technical components of subsystems. Consequently, FSR activities become more focused in a spatial dimension. Socio-economic surveys in the diagnostic stage may focus on all villages in a large geographical region, while field experiments in the testing stage may only involve a few farms.

Temporal Dimension

Whereas in the spatial context activities can be categorized by the focus area (i.e. region, district, village, farm, etc.), in a temporal sense, FSR methodology can be divided into diagnostic, design, and testing stages.

Figure I. Outline of Farming Systems Research Methodology

```
REGION          DISTRICT          VILLAGE          SUB-SYSTEM          COMPONENT

/----------------------------------------\
|    TARGET AREA & SITE SELECTION        |
|    (Agroecological Classification)     |
\----------------------------------------/
                    |
       /------------------------------------------------------\
       |  RAPID RECONNAISSANCE (Qualitative site description)  |
       \------------------------------------------------------/
                    |                              |
       /--------------------\   /-------------------------------------------\
       | INFRASTRUCTURE     |   |          SPECIAL PROBLEM ANALYSIS          |
       | ANALYSIS (credit,  |   | Survey:use survey crops, trees, commodity  |
       | marketing, inputs) |   | of land, livestock, homestead, & discip.   |
       \--------------------/   | Labour,& cap. fisheries surveys *          |
                 |              \-------------------------------------------/
                 |                    |                |              |
                 |              /-----------\   /----------------\  /-------------\
                 |              | FARM LEVEL|   |SUB-SYSTEM      |  |SUPPORT      |
                 |              | STUDIES   |   |STUDIES(on-far  |  |RESEARCH     |
                 |              | (by farm  |   |exp. to screen  |  |(on-station  |
                 |              | size)     |   |existing tech.)|  |experiments)|
                 |              \-----------/   \----------------/  \-------------/
                 |                    |                |                  |
                 |                    |                |                  |
                 |       /-----------------------------------\            |
                 \-------| DESIGN OF TECHNICAL ALTERNATIVES  |-----------/
                         \-----------------------------------/
                                        |
                              /-------------------\
                              | ON-FARM TESTING   |
                              | (Research managed |
                              | and supervised)   |
                              \-------------------/
                                        |
                           /------------------------\
                           | MLT & PILOT PRODUCTION |
                           | PROGRAM (farmer)       |
                           | managed & ext. super.) |
                           \------------------------/
             /-------------------------------/
             |
 /--------------------------------\
 | TECHNOLOGY TRANSFER (DAE)      |
 \--------------------------------/
```

* Examples : Crop varieties, animal diseases, citrus micronutrient fertilisation, aquatic plant uses, family mntrition deficiencies.

1. DIAGNOSTIC STAGE

The problems of agricultural production cannot be solved without a basic understanding of the real constraints affecting the farmer, the relative economic importance of these problems, and the cost of solutions from the farmers' standpoint. Farming systems research as a methodology seeks to improve upon previous compartmentalized research, which gave little attention to the costs of solutions and to whether these costs were ecolomically feasible for target group farmers.

a) Goals for the diagnostic stage

1) Description of existing farming system.

2) Analysis of agroecological and socioeconomic factors.

3) Identification of production constraints.

4) Detection of component inter-relationships.

b) Procedures in the diagnostic stage

1) Analysis of secondary data.

2) Rapid rural appraisal (informal surveys).

3) Special purpose surveys (formal surveys).

During the process of selecting farming systems research sites, initial attention is given to agroecological and socio-economic factors in the demarcation of recommendation domains. Once this "zoning" operaiton is complete, emphasis shifts to a stratification of farms within each domain into "target group" and "non-target group" farms, according to predetermined policy criteria. While surveys genrally incoorporate informants from the entire farming sector for comparison purposes, technology design and testing is primarily restricted to those target group farms with less than one hectare of arable land.

Secondary data on soil types, population densities, land use capabilities, rainfall distribution, the amount of agricultural produce marketed over time, livestock populations, etc. is invaluable during this site description stage. Informal (exploratory) surveys conducted by the entire site team in unison are useful in problem identification and the subsequent priority ranking of research priorities. These are followed by surveys using formal questionnaires, which quantify subject matter areas of interest and aid researchers in the formulation of hypotheses regarding why farmers manage their resoruces as they do.

Finally, special purpose surveys on specific problematic issues, such as credit availability and use or the incidence of a particular crop pest problem, may be necessary to complete the data base in order to make planning decisions. Sample design and survey methodology in this case will be depend on the purpose of the survey. This type of survey is also used at the end to monitor adoption levels and to identify problems needing further research.

2. DESIGN STAGE

Since it is impossible to work at the same time on every problem identified for every aspect of a farming system, a priority ranking of the problems is necessary. Problems that can not be solved by existing teams are sent to appropriate specialist institutions or additional expertise is solicited. Problems that are external to the farming system, such as those ralating to land reform, pricing, and marketing, are referred to policy makers and planners. Problems that can be handled locally are investigated in a systematic way, employing a variety of methods and techniques.

a) Goals of the design stage

1) Determination of research priorities

2) Screen existing technologies to solve target problems.

3) Formulation of improved production technologies.

b) Procedures in the design stage

1) Case studies of specific subsystems.

2) On-station experiments.

3) On-farm experiments.

Once a list of research problems has been developed after a thorough analysis of farming systems and external factors in the recommendation domain, each problem is weighted according to the potential impact of solutions and according to the ability of the FSR to address the problems. For some problems, existing technology from previous research in Bangladesh or in other countries may be immediately applicable, but for others several years of research involving many different academic disciplines may be necessary. As the FSR team evaluates and ranks the problems identified, short-term and long-term research plans are developed. Long-term activities will often involve changes in the credit or input supply institutions, while short-term research can be implemented within the existing infrastructure.

Where technology developed is advanced but not yet ready for on-farm testing, on-station experimentation my be required. For example, if a problem of disease susceptibility in local rice varieties is identified, this problem may be directed to plant breeders in BRRI regional research stations. If on-station research has already selected resistant varieties, these varieties may still require on-farm screening to best match other characteristics (adaptation to soil acidity, grain type, etc.) with those of the farmer's local variety. In the crop subsystem, on-station experiment can involve many more treatments and much more complicated experiemental designs than are possible on small plots in farmers' fields. With animals, on-station experiments allow much more control over on-experimental variables.

As a final step in the design of promising technologies, an exercise in "economic pre-screening", or "ex-ante analysis" as it is sometimes called, is an useful tool to aid in the selection of treatments for on-farm testing. This activity not only confims the prioritization of technical alternatives to solve a given problem, but also identifies the evaluation criteria and essential data that must be collected during the testing stage to determine if the promising technologies are economically feasible for the specified client groups.

3. TESTING STAGE

When prototype technologies for major constraints have been designed, they must be fine-tuned to the specific condition of the production environment through on-farm testing.

a) Goals

1) Evaluate promising technologies on-farms under farmer management.

2) Determine the adaptability of the new technologies throughout the recommendation domain.

3) Increase extension involvement in technology screening.

b) Procedures

1. On-farm experimentation under farmer management.

2) Multilocation testing under extension supervision.

3) Pilot production program (whole farm analysis).

In on-farm trials, it is necessary that the farmer himself be a participant, so that his experience and knowledge can be incorporated into the refinement of the technologies. This also provides insights into the criteria used by farmers in assessing a new technology. The number of farms involved will depend on the nature of the experiment. However, all trials must include the a check plot with farmer practices against which the new technologies will be evaluated.

At the outset, the management of trials will be under research management, so that the number of treatments being screened can be rapidly reduced. Those treatments, whose agronomic and economic superority have been fonfirmed, will then be included in series of farmer-manged trials. In this valiadation of technology, extension personnel also play an active role, especially as the methodology proceeds into studies of farmer adoption levels.

In order to verify the performance of alternative technologies in other parts of the recommendation domain, multilocation testing is needed. This also encourages the spread and transfer of these technologies to more farmer over a wider area. Extension workers gain confidence in the new technologies through participation in multilocation testing, and local extension personnel assume much more responsibility in monitoring these trials and collecting the preseribed data. A strong and viable research extension linkage is essential for forsuccess at this stage of FSR methodology.

Multilocation trial also allows researchers to determine the yield stability of a promising technology over sites. Since the soil types, rainfall, and even management levels (e.g. dates of planting and weeding) may vary in the different locations, yield stability analyses also provide an indication of how a technology will perform in relatively poor production environments, as well as those more conducive to high yields. Economists can caluclate the net benefits derived from serveral promising technologies over this gradiation of production environments. The statistical variation in the net benefits calculated for each treatment can then be used to compare the level of risk that farmers would experience if using the different technologies. Other "risk sensitivity" analyses can also be employed to estimate the risk factor of a new technology compared to the farmers' practice.

If the results of these multilocation trials are positive, a pilot production programme is initiated. Fewer farmers are involved in the pilot production programme. Prticipants utilize the technology on a full production leive, rather than on small plots, without being supplied with inputs and management suggestions by researchers. Pilot production programmes allow researchers to evaluate the effect of a new technology on other system somponents through a "whole farm" analysis. At the same time, any constrainst related to input supply and marketing can also be detected. In most cases, the output of this research

process is not just a subsystem component, such as a new crop variety, input, or new veterinary product, but rather an alternative set of technological options that encompass the farm production system as a whole.

III. COMMUNICATIONS IN FSR

The flow of information among the members of an FSR team, between the FSR team, extension for agricultural development. Highlighting the operational mechanisms of this communications at each methodological stage of FSR aids in making communications personnel and farmer and between farmer themselves is essential more effective. Ideas are normally conveyed within research institutions in the form of written reports and special publications. In most cases, these are in English, which limits their usefulness as communication media for farmers. However, when dealing with extension personnel and farmers, farming systems researchers and to rely more on oral forms of communication. How can one measure and evaluate the flow of information at differnet stages of FSR methodology ?

Communications within the FSR team

As researchers gain experience in FSR, they develop diagnostic and analytical skills that are often difficult to communicate to others outside FSR. Often these skills involve multidisciplinary perspectives gained from exposure to other academic disciplines represented on the FSR team. However, at first, it may be difficult for biological scientists to develop an appreciation for the contributions of social scientists in FSR (or vice versa).

Once cross-disciplinary communications have been mastered, a second more serious problem must be faced. What do you do with all the voluminous quantities of information and ideas generated in the course of assessing a farming system, considering technical alternatives to the problems identified, and evaluating the performance of technical options in field trials ? Do they go into dusty files at the site?

Office, never to be seen by outsiders or are they condensed and summarized in a tidy fashion in reports, which then gather dust in the office of the FSR project coordinator of each institutions ? Who is responible for processing this information at the site, institutional, and national levels of the FSR bureaucracy in Bangladesh.

Research - Extension Interaction

Although constant interaction between researchers and extension workers is necessary at all stages of FSR methodology, what are the specific operational mechanisms of communication ? Since extension personnel theoretically link the "information generators" (researchers) to the "information users" (farmers), can it assumed that data storage, retrieval, and facilitation is their responsibility ? Should farming systems researchers only concern themselves with data collection, processing, and reporting ? Some major policy decisions are urgently needed regarding the management of information within the national research-extension framework of FSR in Bangladesh.

At the FSR site level, it is recognized that there is a gradual shift in the responsibility for the supervision of field trials from researchers to extensionists as activities enter the testing stage of FSR methodology. To facilitate improved research-extension communications as research progress through the methodological stages certain formal research-extension interactions should be incorporated into the workplans of FSR systems research at each site.

1. MEETINGS

Field day tours of on-farm experiments and multilocation testing sites should be held each season. Researchers and local extension personnel must work closely together in organising and conducting these field days. Many teams find "farmer group meetings" to be an excellet means of obtaining immediate feedback from farmers to confirm hypotheses regarding the farming systems and to screen treatment levels for on-farm experiments. Cooperation is also necessary in designing the annual FSR workplans during the meeting of the District Technical Committee.

2. FIELD ACTIVITIES

As was mentioned in the previous discussion of the testing stage of FSR methodology, extension personnel play a much more active role in multilocation trial, pilot production programs, and extension demonstrations. Researchers are involved, but primarily in the planning and monitoring of these activities, rather than in the day-to-day field supervision.

3. IN-SERVICE TRAINING

Optimal research-extension linkages at the site level can only occur if extension personnel understand the philosophy, terminology, and methodology of FSR and their role in the implementation of FSR at the site level. Attaining this "farming systems perspective" requires both a formal and informal educational effort at each site, with extensionists learning from researchers while on the job. This called "hands on" or "in-service" training.

Research-Farmer Interaction

The interaction of the site team and local farmers also occurs at all stages of FSR methodology. Farmers play a vital role as both informants and participants during the various field activities. Continual farmer feedback is essential to insure the research priorities and research direction of the FSR team are valid. As an FSR team gains credibility and establishes a rapport with local farmers, team members often find that farmers view them in the same advisory capacity as extension personnel. Like it or not a successful FSR team functions in a delivery role similar to that of extensionists, passing new information and inovations directly to farmers through their field activities.

Institutional Flexibility

As we have seen, FSR requires multidisciplinary teamwork at the site level. Since staffing each site with a complete multidisciplinary team to deal effectively with all subsystems in a farmin system is difficult at best, each research institution must organise and maintain a multidisciplinary "FSR Task Force" to supervise and assist their field teams. Several of the institutional members of the NCFSRP also maintain a computerised centralized data processing and storage unit.

At the same time both research, extension, and development oriented institutions must work together in a specific institutional and intra-institutional flexibility and considerable coordination (networking) at the national level to exchange information and keep field workers informed of progress in projects outside their immediate geographcal area. Learning the conceptual framewrok of FSR methodology and understanding the descriptive models concerning the flow of information in FSR are but the first steps in the long journey of FSR implementation.

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FARMING SYSTEMS RESEARCH METHODOLOGY

M. Rais Uddin Ahmed

Introduction

By its iterative dynamic nature, Farming Systems Research (FSR) is evolving. In the Asian Rice Farming Systems Network (ARFSN) it was convenient to initially "ride" on the Cropping Systems Research (CSR) methodology leading to Farming Systems Research (FSR). The later was developed by the ARFSN working group of researchers. It consists of site selection, site description, design, testing, preproduction evaluation, and production program. The FSR methodology is an essential tool for developing environmental specific technologies depending on the available farm enterprises to increase the income and productivity of the farm family. By it's very nature, it involves in on farm site research that studies the whole farming systems. Improvements in the methodologies will be made as experience is gained and as more information is made available about the experience of others who are also attempting to conduct FSR with farmers on their farm.

Farm enterprise determination

A detail survey is needed to identify the farm enterprises. The cluster method of sampling with a developed questionnaire using the following heads may be used for this purpose :

a) Crops and cropping

b) Land utilization (Low, medium and high)

c) Labor (availability, off farm opportunity, both for human and animal)

d) Capital flow

e) Income sources and distribution

f) Livestock status

g) Fish production opportunity

h) Marketing facilities.

At least 50 farm families need to be selected from any section of the village is essential before going to select model farmers from different groups for whole farm analysis and monitoring.

Criteria for the selection of model farmers

The following criteria should be used to select the model farmers from different groups :

1) Own farm land (farm size depending on the farmer group)

2) Pure farmer (mostly depended on agriculture)

3) At least two family labors

4) Own homestead area

5) Single family (not sharing the homestead area)

6) At least two animal power

7) One milky cow

8) Dikes (if available)

9) Primary education of the model farmer (if available)

10) Co-operative and road communication are also essential requirements for the selection of model farmers.

Selection of primitive farmers

Beside model farmers or participating farmers, the same number of nonparticipating farmers have to be selected in the site for time to time comparison. The number of nonparticipating farmers may be reduced to one from each group following the same criteria as used for the selection of participating farmers or model farmers.

Selection of FSR site

There are three types of FSR site involved in the FSR.

1. FSR site at farmers field managed by the farmers which is very common in every country of the Asian Farming Systems Research Network.

2. FSR site at farmers field but managed by the researchers which may be termed as FSR field laboratory. All the farmering systems components like cropping systems, livestock and fishery will be incorporated this type of FSR site. This type of FSR site or FSR laboratory is common where land and labor are limiting factor. The land is taken on contact basis from the farmer for certain years. The land is used for component technology trial over farmers' predominant one. The technologies which showed profitable,

socially acceptable may be transfer to the model farmers. Besides model farmers, these may be transfered to the MLT farmers in similar agro-ecological situation.

3. FSR site at the farmers field managed by the farmers but the land is taken as lease for certain years. The participated farmers will manage the site as per suggestion of the researchers.

He will take all the harvest of the tested technologies what ever tested at the site. This farmer will act as an ideal farmer. A good linkage will be made by this systems among the ideal farmer, model farmer and MLT farmers. This type of FSR site may be selected where land is a limiting factor but less off-farm opportunity.

Whole farm analysis

Whole farm analysis of the model farmers who are representative from different groups small, medium and big, should be done by the using the previous data collected during farm enterprise determination or we may say at bench mark survey. The researchers from inter disciplinary will be involved during the whole farm analysis. Complete decision will be taken by the group and will design some improved alternative technologies for the model farmers. The whole farm analysis may be done by the following ways :

1. Integrated crop-livestock enterprises

The firm step in whole farm analysis therefore, is to compare what is already known with what is required for crop-livestock research :

1) determination of improved cropping pattern,

2) determination of feeding pattern,

3) determination of labor opportunity pattern

4) determination of marketing pattern for different commodities.

In most cases what is needed is : (1) a comparison of the feed availability by season and the apparent feed requirements of the present livestock to define present feeding problems; (2) an assessment of farmers' goals and objectives concerning their farming activities so as to better design the research according to the farmers' felt needs; (3) information on how farmers value their livestock, livestock products and livestock feeds; and (4) information on the various costs in raising livestock, including the labor requirements, and on the present level of animal productivity, marketing opportunities, livestock health status etc. could be important in some conditions.

Feed profile development

A large part of livestock feed in Asia presently comes from the crops and crop by products grown on the farm. Previous knowledge on the cropping patterns followed, yield levels and crop/by product use, on farms, can therefore provide a large part of what's needed to develop a feed profile. Crop yield data can be used to estimate the amount of animal feed potentially available from crop production. Straw to grain ratios for the various crops and crop varieties can be used to estimate the amount of plant by products available. Standard figures available can be used to estimate the feeding values of crops and crop residues (Castillo 1983).

Knowledge on how the crops and crop by products are stored and can be relatively available throughout the year. Much more variable from season to season and to difficult to measure is the supply of cut grasses, leaves and fodder from grazing. cut grass and leaves available can be estimated by the volume and (by conversion) air dried weight. Feed nutrient content is estimated by judging moisture content and by recognizing the composition of the grasses and leaves. De Boer (1983) feels that the grazing activities can be considered as exogenous to the major research activities. However it may important to try to document the time required for livestock care and feeding because livestock could compete with crop productive for labor, especially during peak crop production periods (Van Der Veen 1981).

After a feed profile is developed, attention must be placed on describing the livestock enterprises. The animal profile must describe "the primary factors influencing feed requirements such as gestation, lactation, draft requirements, species, age, sex, size, exercise factors involved in grazing, changes in herb/flock inventories and seasonal weight changes' (De Boer 1983). The feed requirements then can be calculated by using standard tables from a text on animal nutrition such as that by Ranjhan (1980).

Farmers' goals, objectives and preferences

Comparisons between the apparent feed availability and feed requirements define particular feed supply problems with the present livestock. This information is useful in deciding how to intervene in providing the type and quantity of livestock feed when needed.

However, in many cases, farmers may be interested in changing the size composition and/or purpose (poultry for meat instead of egg production for example) of their livestock enterprises. Farmers should be interviewed therefore about their goals, objectives, preferences, etc. about raising livestock. They should also be questioned about their self needs concerning the type, quantity and timing of availability of increased livestock fodder.

Taking into consideration farmers goals, objectives and felt needs allows the planning of intervention which focuses on farmers' aspirations for the future and not only on their present needs.

Marketing of livestock and Livestock feed

It would be useful to develop an understanding of the animal feed buying and selling practices of farmers. Knowledge on the prices or exchange rates for various animal feeds, by season, helps in the analysis of the relative net benefits of alternative cropping patterns. Finally one has to be aware of the values the farmers place on their various livestock and livestock by products.

Steps For Crop-Livestock Research In Rice Based Farming Systems

The Asian Farming Systems Network plans initially to carry out crop livestock research on a whole farm bases. However, a number of preliminary steps could be taken for the design of whole farm research and for the initiation of crop-livestock research at most any existing cropping systems site. These could include : (1) reviewing cropping systems research; (2) ex-ante evaluations; (3) including fodder crops in cropping pattern trials (4) testing fodder crops on uncultivated land and (5) feeding and supplementation trials.

Review of cropping systems research

A number of cropping pattern trials have already been conducted at most cropping systems sites. These trials were mainly evaluated according to the relative values of the grain yields minus input costs. Little attempt was made to place a value on crop by products for animal feed. One step that could be taken, therefore, would be to go back and recalculate the relative net benefits of the alternative cropping patterns already tested by taking into account the value of crop by products. The quantity of crop by products produced would to be estimated by straw/grain and/or other appropriate ratios already available. Values of by products could be calculated on the based of the selling prices existing at the site or if a certain by-product is not sold, on the basis of it nutritive value, or on farmers' evaluation.

The re-evaluation of cropping systems trials results by taking into consideration the value of plant by products for animal feed could result in a change in the rankings of the tested cropping patterns according to their relative net benefits to farmers.

Ex-ante evaluation

Estimates of how the improvements in the cropping system followed on a farm would effect the livestock enterprises and net income could be made by existing information.

The changes in the quantity and quality of livestock feed potentially available from improved cropping systems can be calculated by comparing the productivity and plant composition of existing cropping systems with the alternative new one (s).

From previous research, livestock scientists have an idea of what the effects of changes in feed availability would have on livestock productivity or on the number of livestock which could be raised.

Fodder crops in cropping systems research

Fodder crops have generally not received a great deal of attention in cropping systems research in the past. In most cases fodder crops were not the responsibility of the agronomists who carried out cropping systems trials.

Also the greatest early impact on farmer productivity and income generally come from work on food crops where improved technology was readily available.

With the participation of livestock scientists in the network however, the introduction of fodder crops in cropping systems trials becomes more feasible.

Cropping pattern trials could be designed with the inclusion of fodder crops which better meets farmers' felt needs.

Animal scientists should be included in the design of the trials to provide information on the fodder crops to be tested.

In most cases the methodology for conducting cropping pattern trials can be followed. Animal scientists, however can be useful in measuring and interpreting yields and nutrient contents. Typical measurements are taken on :

1) dry matter

2) crude protein

3) ash

4) crude fiber

5) nitrogen of re-extract

6) crude fat

7) gross energy

8) calcium and phosphorus

Actual feeding values of a feed can be measured and verified, on experiment stations, with digestibility trials.

Perennial fodder crops on uncultivated land

Trials could also be initiated in establishing fodder crops on land which is not cultivated. These trials could include grasses and/or legumes on pasture land, forests, under coconut or rubber trees and/or on bunds. Trials with fodder trees could also be initiated.

The design for fodder crops on uncultivated crops would be determined by farmers' needs and resource base but also according to the technology available.

Care must be taken to protect the crops from grazing in order to measure yields. Yield measurements and assessment of nutrient contents could be carried out in a similar manner as for fodder crops in cropping systems trials.

If grazing does take place, the fodder crops could possibly be evaluated according to vigor of crop growth, according to ability to withstand heavy grazing and according to farmers' opinions.

Feeding and supplementation trials

In some cases knowledge does not exist on the effect of certain feeds and/or supplementation on the productivity of livestock on farms. Conducting feeding trials, on farms, is one way to try to measure the effects of alternative feeds on livestock productivity.

However, for a number of reasons, it can be difficult to achieve statistically significant differences with feeding trials on farms (De Boer).

1) It is very difficult, if not impossible, to find a sufficient quantity of similar livestock for replications.

2) The feeding treatments probably have to be carried out on a number of farms which probably differ in management, housing system, animal health status etc.

3) Measurement of feed intake and utilization is very difficult, even if the animals are completely confined.

4) The measurement and valuation of changes in productivity is difficult because changes can take place over a long time period and can be multi-dimentional i.e. body weight and meat quality, level and content of milk produced, working ability, reproduction performance etc.

If the initial productivity of the livestock is not known prior to the initiation of the trial, farmers who are very familiar with their own livestock, can probably give a good assessment of the effects of the new feed on their animals.

Typical periodic measurements taken during on farm feeding trials are : (1) body weight; (2) level and quality of milk produced; (3) feed offer; (4) feed intake; (5) feed costs; (6) animal health; (7) reproduction; (8) amount and content of animal waste etc.

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SETTING RECOMMENDATION DOMAINS

M. Z. Abedin

DEFINITIONS

Recommendation : a solution proposed for groups of farmers that is based on their problems and their circumstances.

Recommendation domain : a group of roughly homogeneous farmers with similiar circumstances for whom more or less the same recommendations can be made (CIMMYT/Byerlee 1990).

Hypothesis : a question to be answered or a tentative conclusion to be tested in a formal or informal survey or experiment.

Opportunity : a favourable or promising combination of circumstances that provide a chance for improving the system or solving a problem.

1. Rationale for grouping farmers

We have to group farmers when we are thinking about conducting research. At one exterme, we do not have sufficient resources to carry out a specific research program for every individual farmer. At the other extreme, it does not make sense farmers in a country. We must compromise between these two extremes and plan research relevant to groups of farmers.

The purpose of groups is to highlight similarities within groups and differences between and among groups. Similarities and differences are important only with respect to our objectives : increasing agricultural productivity by establishing experiment and generating recommendations.

2. Variable used to group farmers

Because farm families differ from one another, we need to distinguish the variables on which they vary and how those variables relate to the problems they have and the utility of solutions to those problems.

How do development agencies generally deal with grouping farmers ? Some research institutes divide their countries into agroecological zones and develop packages of recommended practices and technologies appropriate to each zone. Traditional approaches to grouping farmers have usually involved geographical zoning using one or more variables, such as :

Amount of annual rainfall
Number of humid months
Crop potential
Agro-climatic zones

In many countries there have been cases of development projects extending packages across large zones and finding that these packages were appropriate to only a minority of farmers in the zone. Grouping farmers according to the physical characteristics of a geographic area is often not sufficient for delineating groups; different groups within the zone may each require different research programs. For example, due to differences in farm size for various reasons, there are tenant farmers and landlords in Barind area of Rajshahi district of Bangladesh. Do they have the same problems ? Would you solve them the same way ? Would you carry out the same research program to solve even their similar problems ? Land preparation is the major problem for the small farms have zero grazing. The big farms have access to labor all year round, while on the small farms, the males migrate part of the year to earn cash.

Specific groups of farms require specific research program to generate recommendations which meet their needs. Do small vegetables farmers at the outskirts of the capital city require the same vegetables research and extension program as farms 100 kilometers away but in the same agro-climatic zone ?

In FSR/E, we propose grouping farming according to :

- The similarity of their problems;
- Their expected response to solutions of their production problems.

Farmers with similar circumstances often have similar characteristics in terms of objectives, resources and constraints, strategies and practices. What kind of characteristics can we find that indicate that farmers have similar circumstances ?

a) Farmers practices are useful for grouping farmers

<u>Access to irrigation</u> : In Barind area rainfall is very irregular. Some farmers have access to irrigation. Because it is difficult to predict how often it will rain, the recommendation that the farmer plow and plant immediately with the first rain was not followed. Experience had shown farmers it is less risky to plant late during the Aus (early kharif) season to ensure that crop will not fail. Only farmers with access to irrigation water followed the early planting recommendation or grown winter rice cropping.

b) **Biological and physical characteristics of farms are useful for grouping farmers**

<u>Altitude</u> : In some area altitude was found to be a critical variable in differentiating farmer groups. Farmers living in areas above 2000 meters had higher rainfall and lower evapotranspiration rates. They thus had different crops - beans maize and irish potatoes - than farmers at lower altitudes who grow may be sweet potatoes, beans, bananas or other crops. The principal problems of farmers in the high altitude zone were wind and hail, in the lower altitudes insects and plant diseases.

c) **Labour availability is useful for grouping farmers**

<u>Labor availability</u> : In the Dominican Republic, a project to raise tethered milk cows started. Traditionally, the farm women had raised goats which they let graze during the day and herded into sheds at night. Because gathering fuel and carrying water required a great deal of the women's time, they did not often have the time to gather fodder for the tethered milk cow, nor to make sure the cow did not strangle on the tether. Only those women farmers who already had tasks associated with confined animals as part of their daily activities were successful in raising the cows.

d) **Access to lands, labor and capital are useful in grouping farmers**

<u>Access to credit</u> : In Bangladesh, farmers with low rice yields were advised to apply fertilizer. Some farmers with clear title to their could do so. Many farmers, having no collateral, were unable to get credit.

e) **Productivity of land can be used to group farmers**

Productivity of land differs from place to place due to physical and chemical properties of soil. Availability of irrigation water also greatly influences the productivity and farmers income. Continuos cropping with inappropriate management practices can negetively affect soil fertility and productivity. This in turn affects the income of the farmers.

f) **Availability of food in the household level can be used**

Some farmers are deficient in food throughout the year and some are for the part of the year. Some are not at all deficient. Priorities of these different farmers do differ.

g) **Cash flow as another crieterion**

Because of the existing farming systems or earnings from various other sources like, a son having job elsewhere or the farmer doing apart-time business, the cash availability in the family differs from others. This makes the farmers different in respect of their ability to adopt certain technology.

No characteristic works every time in every situation. In each situation, researchers must use their own judgement in deciding which variables are most important in distinguishing farmers in an area. Those variables which have the most to do with farmers problems and solutions to these problems are the primary candidates for use in defining farmer groups.

Fortunately, there is usually a high degree of correlation among variables used for defining farmers groups. For example, as altitude decreases, rainfall decreases, evapo-transpiration increases, and temperatures increase. These changes bring about changes in cropping patterns, planting dates, farmer problems, and socio-economic status. Since these variables were all highly correlated, it is possible for researchers to divide the area into just to farmers groups, those living in high altitudes and those living in low altitudes. Farmers in each group have roughly similar circumstances, similar problems and similar opportunities.

3. **Recommendation domains : Issues to consider**

Several important issues arise in defining recommendation domains :

a) <u>The dynamic nature of defining recommendation domains in the research process</u>

Since the concept of farmer groups is used throughout the research process, the way groups are defined may change according to the task at hand. The following table, adapted from Tripp, 1985, shows how the concept of grouping farmers is used at different stages of the research process :

<u>Research stage</u>	<u>Use of grouping farmers</u>
Analysis of farmer circumstances	define groups with similar circumstances
Identification of priority problems	specify which farmers have the same production problems

Selection and testing of possible solutions	identify possible solutions appropriate for particular groups of farmers and select sites for testing
Develop recommendations	tailor recommendations to needs and circumstances of different farmers groups

b) <u>There is a fundamental difference between defining farmer groups and defining agro-ecological zones</u>

The difference is that farmer groups are defined by farmer circumstances, practices, problems, and solutions, while agro-ecological zones by the physical and biological characteristics of geographical areas.

Of course, farmers' circumstances and practices are often determined by physical and natural circumstances. Nevertheless, it is important to remember that it is people, not physical or biological characteristics, that decide whether or not to adopt a given technology. Thus, defining farmer groups forces researchers to continually ask, "For whom is the research being done" (Tripp, 1985).

c) <u>Two farmer group may be interspersed among each other in the same zone</u>

In most developing countries like Bangladesh, high income and low income farmers are found almost in each village grouping farmers by zone may be a useful first step in defining farmer groups but we must redefine groups within a zone.

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DEFINING RECOMMENDATION DOMAINS FOR ON-FARM/FSR

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DEFINITIONS

Recommendation domain has already been defined as a group of farmers whose circumstances are similar enough so that they are all eligible for the same recommendation. It should be emphasized that the domain is a group of farmers, not a geographical area or land type. Domains are composed of farmers because farmers, not land types, take decisions on new elements of technology. Defining domains in terms of groups of farmers underlines the possible importance of socioeconomic criteria in domain identification. It also allows the possibility of domain distinctions that are not amenable to mapping (neighboring farmers can belong to different domains or, as well, a given farmer can belong to more than one domain).

It usually happens that there are a number of research opportunities for a particular commodity, or even for several commodities, that a group of farmers have in common. These opportunities should of course be considered together, taking account of their interactions and relative importance as plans for a research program involve. It is natural to think of the group of farmers that share these opportunities as a single recommendation domain. But because two groups of farmers may share some opportunities, but not others, it is well to remember that a recommendation domain is really specific to a particular enterprise and a particular research problem. That is, our interest is in defining the group of farmers for whom a specific recommendation is applicable.

Research area in this paper will simply mean the area in which investigation is to take place. This is usually defined by the research institution and may have administrative or agroclimatic boundaries. Although the concept of recommendation domain is often quite helpful in refining these boundaries, we will assume here that the research area is given. Our job is to take the mandated research area and decide how it should be divided into recommendation domains.

Farmers' circumstances are used in order to identify recommendation domains. They are defined as "all those factors which affect farmers' decisions with respect to use of a crop technology. They include natural factors such as rainfall and soils, and socioeconomic factors such as markets, the farmers' goals and resource constraints" (Byerlee, Collinson, et al. 1980 : 70). Figure 1 shows how circumstances may affect farmers' practices and their abilities to adopt new recommendations.

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* Source : CIMMYT Working Paper.

__A recommendation__ is a description of a new element(s) or elementas in a production technology (an improved variety, a new chemical, a different practice, a change in the timing of an operation, etc.) which researchers believe farmers will find useful. In the case of the on-farm research paradigm described here it is derived from an understanding of farmers' problems and a thorough testing under farmers' conditions. Recommendations are sometimes made in groups or "packages", as when a new variety is recommended along with a certain planting density, insect control and fertilizer level. This is particularly important when there are strong interactions among several elements. The emphasis, however, should always be on recommendations that farmers can adopt in a step-wise fashion. There is now considerable evidence that farmers are more likely to adopt simple recommendations and make changes gradually, rather than make abrupt, large-scale changes in their practices (e.g. Byerlee and Hesse de Polanco 1982). Thus on-farm research identifies and tests technologies with a limited number of new elements under farmers' conditions, to find out which recommendations can be accommodated by farmers.

Recommendation domain formation can be thought of as a process of considering all the various circumstances that might affect farmer practices and deciding, for each one, if it is the basis of significant differences in practices and possibilities within the research area. One way of making this operational is to think of a checklist, such as that in Table 1, which lists major categories of circumstances that may be used to define recommendations domains. The list is by no means complete, and researchers working in different areas will surely add other factors to this list. It will also be appreciated that many of these factors are interrelated: altitude affects temperature and frost incidence, for instances, and rainfall affects weed population.

Several examples may make clear how the variables on this checklist can be used to define recommendation domains. Consider the case of soil differences, which are often important in determining farmer practices. In one research area in southern Veracruz, Mexico, there were two basic soil types. Farmers in the river flood plain had alluvial soils and grew wet season vegetables and dry season maize. Neighboring farmers had sandy, acid soils and grew pineapple and maize, in the wet season only. The difference in soils is responsible for very different maize practices and problems with respect to such factors as moisture stress, disease and insect incidence, and fertility requirements. Recommendations about maize appropriate for one group would not likely be appropriate for the other. Thus we have two separate recommendation domains for maize, in this case determined by soil type.

Table 1 : Variables often considered in forming recommendation domains.

Natural circumstances	Socioeconomic circumstances
<u>Climate</u>	
Temperature	Farm size
Frost incidence	Land tenure
Rainfall pattern/quantity	Access to markets and inputs
Risk of drought	Access to family labor
Risk of flooding	Access to other labor
Altitude	Access to credit
<u>Soil</u>	
Texture	Access to cash
Drainage	Access to markets for selling crops.
Slope	Power source
Depth	Access to irrigation
Nutrient supply capacity	Off-farm labor opportunities
pH	Food preferences and diet
Salinity	Community customs and obligations
<u>Biology</u>	
Disease incidence	
Pest incidence	
Weed complex	

There are often differences in soils within a research area. Does this mean they will always correspond to different recommendation domains ? No, not at all. In another part of Mexico, in a highland barley area, soil type varied from clay loam to sandy loam, and researchers hypothesized that these might cause different domains. But a closer study of the area revealed no significant differences in farmers' practices or problems by soil type, and researchers realized that they were either dealing with a single domain, or that another circumstance on their checklist besides soil type might be used for distinguishing different domains.

Another natural circumstance that may lead to significant differences in practices and research opportunities is altitude. In part of the Callejon de Huaylas in Peru, maize researchers identified two recommendation domains, based on altitude. In the lower domain, from 2,600 to 3,000 meters, farmers could plant two crops a year and had serious problems with leaf fungus diseases. In the higher domain, above 3,000 meters, only one crop a year was possible and one of the principal problems that farmers faced was frost damage to their maize.

Altitude here served to distinguish two domains, with different maize practices, problems, and opportunities for research. Again, altitude will not always serve to distinguish recommendation domains. If variations in altitude is not associated with significant differences in farmers practices or biological response then it can be crossed of the checklist.

The same holds true for other natural circumstances. In their study of farmers' practices and problems researchers will want to ask whether such things as rainfall pattern, slope, or pest incidence can be used to define different recommendation domains. Important factors are of course not limited to natural circumstances, and Table 1 presents a number of socioeconomic circumstances that may also be useful in identifying domains. an example or two may be helpful.

It is often the case that farmers who share the same natural circumstances nevertheless have different access to resources which affects their practices and their ability to adopt innovations. In one area in Zimbabwe maize farmers prepared their plots with ox plows before planting. As only about half of the farmers owned oxen the rest had to rent them. The renders were delayed in their planting, which affected their production through drought risk, disease, and other factors specific to late planted maize. There are a series of research opportunities for planted maize. There are a series of research opportunities for animal renters which are not applicable to owners, and thus it is worth considering two recommendation domains, distinguished by animal ownership.

Another case will provide a counter-example. In a research area on the north coast of Honduras most farmers controlled weeds in their maize crop with herbicides, but only one-third of the farmers owned in the backpack sprayers. Researchers believed there might be a differences in weed control practices between sprayer renders and owners. But a survey showed no differences in weed control practices or timing between the two groups and revealed that the rental market for backpack sprayers was quite adequate. Thus access to a sprayer did not affect farmers practices and did not serve to distinguish recommendation domains.

Farmers can also often be distinguished by access to land. Differences in farm size may not only directly affect the type of practice that a farmer follows, but may also be correlated with many other differences, such as access to equipment, credit, or marketing facilities. At times these distinctions are quite clear and are responsible for the formation of different recommendation domains. In parts of the highlands of Ecuador small and large wheat farmers occupied the same natural environment, but their socioeconomic circumstances were quite different. The former relied on animal traction and had not access to credit, while the latter used tractors and credit facilities (which lowered their costs for obtaining fertilizer). This led to quite different practices (e.g. different rotations and fertilizer treatments) and these in turn indicated different research opportunities. The result was two recommendation domains in a biologically homogeneous are -one of small wheat farmers (under 5 ha) and the other of large wheat farmers.

It is of course not always the case that farm size is a determining factor for domain formation. Researchers want to ask if two farmers in a given region with different sized farms use essentially the same technology for a particular enterprise and if they have access to the same type of resources and markets. Do they use the same variety, the same seeding techniques, the same seeding dates, the same fertilizers, etc. ? If there are differences, then there may be two domains. If there are no significant differences, then farm size will not be used in defining domains. In this case researchers will go on and ask the same questions about other natural and socioeconomic circumstances on their checklist (Table 1). If farm size is not important, does altitude or soil type or land tenure serve to distinguish farmers' practices and problems ? If not one or more of these factors, what also on the checklist might define different domains ? As researchers gain more experience in domain formation they will probably rely less on a formal checklist. 5/ But the process is always the same, considering how a series of circumstances affect how a farmer undertakes a particular enterprise.

In the examples considered so far a single factor (e.g. altitude or farm size) has been used to divide a research area into recommendation domains. But it is not always the case that only one factor influences farmer practices and research opportunities. Researchers must exhaust the possibilities on their checklist in the search for relevant circumstances for defining domains. an example of maize research in Peru was discussed earlier, in which researchers identified two domains, based on altitude. In fact, the actual situation was more complicated, as there were other important differences in farmers' circumstances in the research area. In the lower zone there were two principal farm types - small farms averaging less than 2 hectares and large farms averaging 40 ha. These two farm types had quite different patterns of rotation, input use, varietal requirements and maize sales. In the higher zone there were not such marked differences in farm size, but some farmers

5/ Researchers will have their own preferences on how to think about these factors during diagnosis. Collinson (1979), for instance, suggests first considering agroecological factors and then moving to "hierarchical" divisions due to socioeconomic differences.

had access to irrigation while others did not (all farmers in the lower zone had irrigation). This was responsible for significant differences in rotations and input use. Thus there were actually four different recommendation domains in the research area, based on altitude, farm size and access to irrigation.

In order to form recommendation domains researchers must study the circumstances and practices of farmers in their area. Using a checklist of circumstances they can consider in turn various possibilities for defining recommendation domains. It may be that the area is homogeneous enough to constitute a single recommendation domain. If not, there are usually one or at most a few key circumstances that can be used to define domains. This is not to say that the differences between the domains are necessarily simple, but only that there should be a relatively straight forward way of identifying and describing them.

In the case of the two domains formed by differences in altitude researchers are not so much interested in altitude *per se* but rather in the way altitude is responsible for determining two quite different, complex patterns of disease and pest incidence, cropping cycle and varietal preferences. It is these factors that determine the practices that farmers follow and the innovations that they are likely to adopt. It is these factors that dictate two separate sets of on-farm experiments for researchers. Delimiting the two domains in terms of altitude is simply a convenient way of identifying the domains and helping researchers to plan their work. It may be that the distinction between altitude zones is even correlated with other factors such as human population density, with lower densities at the higher

elevations. This would lead to differences in rotation patterns and soil fertility between the two domains, even though there is no *a priori* relationship between altitude and rotation. Again, the denomination of the high elevation and the low elevation domains is a convenient way of describing a whole series of different circumstances among two groups of farmers.

It is often asked if this process of domain formation is adequate for covering all farmers in a research area. Will there not be a few farmers in the high elevation domain, for instance, whose practices are different from the rest ? Or might there not be some farmers whose circumstances are in between the two altitude zones ? There may well be, but are there enough such farmers to make it worth while to form separate recommendation domains ? Recall that domains are formed so that researchers can effectively deal with the majority of farmers in a particular area. The selection of good criteria for domain formation will result in a few large domains, each roughly homogeneous with respect to major research opportunities and current production practices, with distinct differences between domains. There may be some farmers who are not covered by the definitions, but forming special domains for them might not be a wise use of research resources.

Policy variables in recommendation domain formation

The question of which farmers should be addressed by an experimental program is not only related to research efficiency, but also to policy. If several domains have been identified it is often necessary to decide which ones will receive attention. Very often national policy will contribute to making these decisions, as priority may be given to certain types of farmers (small farmers, commercially oriented farmers, etc.) or to certain types of crops (basic grains, cash crops, etc.). As research policy is usually concerned with obtaining high benefits from a given research investment, this also often implies concentration on domains that contain the largest numbers of farmers and present the most promising opportunities for improving productivity.

The relationship between policy and on-farm research is not one way, however. There are substantial opportunities for feedback from on-farm research to policy makers. In the case of recommendation domains there is the opportunity for providing policy makers a much clearer idea of the nature of the farming population. Very often policy mandates are stated in terms of "target groups" whose definition (e.g. " the small farmers of region X") masks considerable variation in circumstances and potential. Dividing the research area into recommendation domains can contribute to much more precise targeting.

Acquiring data for domain formation

There is an apparent paradox in the definition of a recommendation domain. If it is defined as a group of farmers whose circumstances are similar enough to make them eligible for the same recommendation, how can we be sure of the constitution of the domain before the recommendation has been made ? The answer is that we often cannot be completely certain, but as the process of on-farm research passes from diagnosis through experimentation to recommendations researchers become more and more confident of the boundaries of their domains. From the beginning of the research process hypotheses are formed about possible domains. These hypotheses are tested during surveys and the conclusions are used in the design of an on-farm experimental program. At times it is only after a year or more of experiments that researchers are able to make the final adjustments in their domains.

In order to acquire information useful for domain formation adequate data collection methods are required. The initial diagnosis must be done rapidly and efficiently, so that on-farm experiments can be planted as quickly as possible. Thus elaborate studies which collect great amounts of detailed information are not appropriate. The idea is to identify research opportunities and likely recommendation domains and use this information to begin experiments. Procedures for assessing farmers' circumstances are described in Byerlee, Collinson et al. (1980). These procedures include a review of secondary data, an exploratory survey and, often, a short, well-focused formal survey.

Initial hypotheses on variables for dividing farmers into domains may be developed during a review of secondary data for the research area. Keeping in mind the checklist (Table 1) of circumstances which may affect domain formation, the researchers can examine the secondary data with an eye towards identifying possible key factors. Soils maps, census reports or other data may suggest possible sources of variation in farmers' practices. Conversations with local extension staff can also be quite valuable. With the initiation of the exploratory survey the evaluation of these hypotheses may commence. For example, if census data indicated three major land tenure classes in the research area the exploratory survey could be used to ascertain whether these tenure classes had may important effect on farmers' practices or problems. The exploratory survey is the time when the checklist is most fully utilized. By talking to farmers and observing their fields researchers have the opportunity to decide which circumstances on the list are likely determinants of differences in farmers' practices.

During the exploratory survey, development of hypotheses on recommendation domains and hypotheses on research opportunities proceed together. Researchers strive to understand how different

circumstances lead to different practices and problems, and whether or not these differences are relevant to the research opportunities that have been identified. For example, if the important research opportunities in a maize area appear to be insect control and disease-resistant varieties, then soil differences may not define recommendation domains. If, in the same area, the principal research opportunities turn out to be fertilization and moisture conservation then the difference between maize farms on sandy soils and those on heavier soils is probably enough to determine two separate recommendation domains.

There need not be any difference in current farmers practice in order for a particular research opportunity to divide an area into different domains. In one area in Honduras both land owners and renders had similar maize practices, using a maize-fallow rotation which allowed several years between crops of maize on one piece of land. Research opportunities for weed control and variety were the same for both groups. But in thinking about the possibility of intensifying the system by introducing a cover crop of velvet beans which would allow several years of continuous maize plantings, the difference between owners who lad assured access to their plots over time) and renters (who did not) became important, and defined two different domains with respect to this opportunity. The interaction between research opportunities and domain boundaries is therefore quite important.

At the end of the exploratory survey the checklist has been significantly reduced so that researchers generally have only a few possible candidates for defining recommendation domains. The exploratory survey is often followed by a formal survey in which random sampling and a short, well-focused questionnaire are employed. Samples for the survey should be drawn so that each tentative recommendation domain is represented by at least 25-30 farmers. During the survey, information should be collected on the "short list" of variables that are proposed for defining recommendation domains as well as on variables that measure key aspects of farmer practice (i.e., practices related to important research opportunities). Cross-tabulation of "short list variables by farmer practice variables will indicate which criteria most strongly and consistently influence the farmer practice.

The survey analysis should seek to identify a small number of domains, each as homogeneous as possible, which allow efficient research on the highest priority themes. The survey may, for instance, define two recommendation domains with very distinct research opportunities, as in the example of domains defined by altitude in Peru. In that case, research on maize varieties (one of several opportunities) was oriented by farmer responses to a question on principal problems. These at the lower altitude indicated a problem with leaf fungus disease, while those at the higher altitude expressed interest in maize of a shorter cycle because of frost damage.

In other cases, two domains may share at least some research opportunities, but require experimentation under different conditions. Domains that are defined by access to irrigation, for instance, may share chemical weed control in maize as a research opportunity, but different products, levels and application methods may be indicated for each domain. The survey is used in this case to define the circumstances that are representative of irrigated and non-irrigated domains, in order to choose the levels of non-experimental variables for each domain.

Particular care must be taken when proposed for domain formation are proxies for actual practices and conditions. Analysis of the survey should lead to major, as opposed to merely statistically significant, differences between domains. For example, in one survey in a barley producing area tractor ownership was proposed as a criterion for distinguishing recommendation domains. Analysis of the survey showed several differences in land preparation between tractor owners and renders. In the case of early harrowing before ploughing, for instance, 54% of the owners, but only 41% of the renders, did a preplough harrowing. The difference was statistically significant (at 5%) and showed, not surprisingly, a tendency for tractor owners to do a more thorough job of preparing their fields than tractor renders. Differences of this magnitude were observed for several other land preparation methods. They were not, however, sufficient to define recommendation domains. Whether or not the farmer did an early harrowing was affected by competing labor demands, previous crops, soil conditions, and several other factors besides machinery ownership. Thus more effort should be made to specify the complex of circumstances that conditions land preparation methods. The single factor of tractor ownership identified in the survey, although responsible for statistically significant differences in practices, is not sufficient to divide the research area into two clearly distinguishable domains. In the meantime, if research opportunities are identified which interact with land preparation (seeding methods and timing, for instance), then research should be carried out for the major categories of land preparation, using land preparation itself as a defining characteristic of the domains, rather than tractor ownership, which is only a weak proxy. 6/.

6/ This example assumes that land preparation itself is not an opportunity for investigation, which of course may not be the case.

Using domains as a framework for on-farm research

Once recommendation domains are identified they are used as the basis for the on-farm experimental program. Experiments are designed for specific recommendation domains; the exact number of a certain experiment to be planted in one domain depends largely on the type of experiment. If it is an experiment of an exploratory nature then it may be repeated only a few times, while if it is a verification experiment (the stage just before demonstration) then it will be very widely distributed within the recommendation domain 7/.

It should be noted that the number of experiments required for a given domain does not depend on the size of the domain. It was pointed out earlier that one can think of domains as statistical strata, and on-farm experimentation can be considered an exercise in sampling. Each experiment measures that effect of new elements of technology on crop yields, income and risk for the respective cooperating farmers. The benefits of a particular element may be estimated for the target farmer population by averaging the results of several trials. When strata are internally homogeneous (as recommendation domains should be) a small sample from each is sufficient to obtain a precise estimate of the stratum mean. This is because the sample size needed to achieve a desired level of precision at a certain level of probability does not depend on the population size, but rather on its variability.

The experiments are of course planted under conditions representative of the recommendation domain. If the domain is defined as all farmers who have less than 10 hectares, have fields between 2,600 and 3,000 meters above sea level, and do not have access to irrigation, then the experiments for this domain must be planted under these circumstances. Beyond this, the survey will have specified what the representative farmer practices are for the particular domain. Non-experimental variables are usually set at the farmer's level, unless there is the expectation that farmers will soon stop a new practice which warrants being included as a non-experimental variable.

Although recommendation domains can usually be identified before planting the first year's experiments it occasionally happens that the results of the experiments themselves are useful in refining domain definitions. If a domain is a group of farmers who face similar circumstances, follow similar practices and share similar opportunities, then one would expect similar results from experiments planted with different members of the same domain. In terms of analysis of variance, "site by treatment interaction" should not be consistently significant.

7/ For more on the stages of on-farm experimentation, seed Violin, Kocher and Palmer (1981).

When this interaction term is significant (at an appropriate level) researchers should see if this is merely random variation (e.g. because of rainfall differences), or if there is a constant factor (e.g. a previously unidentified difference in soil types) which is responsible. In the latter case, this may lead to a division of what was formerly one domain into two or more. Similarly, when experimental results are consistently uniform across two domains, researchers may consider combining them into one.

Once domain boundaries are firmly identified, the agronomic, economic and statistical analysis of experiments proceeds by pooling the data within each domain. The results are then used to form recommendations for the domain.

__Preliminary zoning__ 8/

At times research programs wish to use a set of tentative domains to organize OFR in a large area. Senior research planners may feed, for example, that one domain may occur in numberous small defined areas (each handled by a different OFR field team). To reduce duplication of effort in on-farm trials, these senior researchers may wish to make a first "rough cut" at domain formation, assigning each OFR field team to work with one or two of them.

In these cases, "zoning" procedures can be used. Specifically, formation of numberous tentative domains in a large area can be initiated by means of a very brief formal survey with local extension personnel that provides data for grouping together farmers with similar farming systems. A OFR teams are assigned to initiate fieldwork, they can accept or adjust the tentative domains identified in the zoning process.

8/ This section draws heavily on the experience of M. Collinson (1979) and S. Franzel (1981) in East Africa.

__Issues and Complications__

As researchers deal with domain formation in their study areas several issues and complications tend to arise. These include questions of domain size, domain permanence and others. The purpose of this section is to discuss these questions and show how they may be addressed.

__Domain size__

What is the appropriate size of a recommendation domain ? There is no set answer to this question, but obviously the larger the domains the more cost-effective will be the research program.

Domain size is influenced by the heterogeneity of the area. In places where there area many different microclimates and great variations in the socioeconomic circumstances of farmers a relatively large number of domains are likely to be identified. In other places, vast areas may be subject to similar circumstances and farmer practices, and a few domains will suffice.

Domain size is also determined by the availability of research resources. More resources allow the exploration of more research opportunities and thus the delineation and management of more and smaller domains. At times these factors may have contradictory influences on domain size, as when work is carried out in every complex, heterogeneous target area with very few resources available for implemention OFR. In these cases a decision is often taken to carry out research in only a few high-priority domains, selected according to research opportunities, farmer characteristics or national policy.

Domain size is thus bounded on the small side by expected returns to research expenditures. Domains should not be so small that benefits from new technology for that domain are less than corresponding research costs (or better, less than the expected returns from alternative uses of research resources). Domain size need not be bounded on the large side. In fact, domains should be as large as possible, with the condition that farmers in the domain can still be expected to adopt recommendations arising from work on major research opportunities. Large domains allow the fixed costs of on-farm trials to be spread over a wider number of users.

In practice, domain sizes demonstrate considerable variation. They have ranged from a few thousand farmers to several tens of thousands, or more. There is clearly no "best" size for a recommendation domain.

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HOLISTIC APPROACH OF FARMING SYSTEMS : CONTRIBUTION EXPECTED FROM SOCIO-ECONOMIST - A SYSTEMS RESEARCHER'S VIEW

R. N. Mallick

The goal of the Farming Systems Research is to generate appropriate technologies for the farmers in farmers' fields. Farming Systems Research and Development (FSRD) is holistic. FSRD views the farm in a holistic manner and focuses on interactions between components. A comprehensive view is taken both human and natural environments of the farm. Research focuses on production subsystems, but the connections with other subsystems are recognized and evaluation of research results explicitly takes in to account linkages between subsystems.

Holistic - Literally holistic means pertaining to holism. Holism is noun and holistic is adverb. Holism means the view that an organic or integrated whole has a reality independent of and greater than the sum of its parts. Holism mean the theory that whole entities as fundamental and determining components of reality, also means have an existence other than as the mere sum of their parts.

Where whole farm setting is looked to identify problems and opportunities, interrelationships, design and conduct experiments, and evaluate results is called whole farms approach.

Whole farms analysis - a methodology designed to research for optimal solutions through incorporation of farmers' objectives, farming systems, and resources to arrive at improved cropping and livestock patterns and management practices for overall farming systems performance.

Whole farm planning - planning which involves consideration of the farm system as a whole, is distinct from partial budgeting.

Whole farm production function - a function relating total farm output to the use of land, labor, and capital on a whole farm basis.

Socio-economic aspect of agriculture plays a great role for inter-disciplinary research of farming systems. Socio-economist plays specific role while studying interaction for meeting multiple objectives of farm - households and resource competition and complementarity, to study conflicts in labour use between enterprises, cash flows from sale of one product for purchase of input for another enterprise, competition for irrigation water between enterprises, choice of multiple crops and production practices to manage risk, planting and storage of food crops to balance seasonal food needs.

Data Collection, Monitoring and Evaluation

- Ø Elaborate more on data collection at testing and evaluation phase.

- Ø Use narrowly focused surveys to understand specific activities.

- Ø Assess gender - specific tasks or gender division of labor through Rapid Rural Appraisal, agro-ecosystems analysis, key informant interviews, group interviews.

- Ø Include women as respondents.

- Ø Conduct intensive surveys and disaggregate labor data by gender and income source from non-farm employment and self-employment activities eg goat, poultry and duck raising.

If the introduction of new technologies force farmers to recognize substantial portions of their activities, either all at once or over time, then whole farm must be studied. It may be done by observing, recording, and estimating all the farmers' activities including the family's nonfarm enterprises.

The systems approach applied to on-farm research considers farmer's systems as a whole, which means studying the many facts of the farm household and its setting through close and frequent contact with household members on their farms, considering problems and opportunities which influence the whole farm, setting priorities accordingly, recognizing the linkages of subsystems within the farming system and considering them when dealing with any part of the system, evaluating research and development results in farms of the whole farming system and the interests of society.

FSRD looks at the interactions taking place within the whole farm setting and measures the results in terms of farmers' and society's goals.

Not all aspects of a farming system must be addressed for the process to be considered FSRD. Cropping system and livestock system and even commodity research may qualify. What is needed for the research on subsystems eg. cropping system to be taken within the context of the whole farm. Such an approach for cropping systems requires a study of the farming system to verify that research into cropping system is justified, that the research on the subsystems and the resulting recommendations fit within the overall system, that the final evaluation is within the whole-farm context. Improvements for suitable agricultural policies and support services should also be studies in FSRD.

1. Sustainability of Technology

Sustainability is the ability of a system to maintain productivity when subjected to stress or perturbation. Steady decrease yields of continuously cropped maize fields on steep slop which causes soil erosion indicates low sustainability. The properties of sustainability is also resistance and resilience.

Sustainability along with productivity, stability and equitability are properties of system. Lack of sustainability may be indicated by declining productivity. These may be expressed as kilogram in biological, Taka in economic and calories in nutritional factor.

Agronomic sustainability can be measured at the field level, micro-economic sustainability at the farm level, ecological sustainability at the watershed level and macro-economic sustainability at the national or regional level.

1.1. Technical feasibility

Ability of a farmer to execute it with a specific resource structure such as labour, chemicals, credit, drought power, equipment and produce markets.

Common Indicators

i) Yield or live weight performance.

ii) Adaptability to adverse condition.

iii) Sustainability to yield.

iv) Farmer's capability and resources.

v) Site specificity

1.2 Economic Viability

Cost of resources and prices of the products produced by the technology.

i) Resource budgeting - peaks and through of resources availability.

ii) Whole farm analysis - return to scarce farm resources like labour and capital.

iii) Partial budgeting - indicators are the additional returns and the marginal benefit - cost ratio.

iv) Enterprise analysis - indicators are cash and non-cash farm income.

v) Market analysis - market demand and supply of the product, market outlets and arrangements.

1.3 Socio-cultural Acceptability - Indicators

i) Adoption

ii) Change in attitude

iii) Decision making

iv) Cultural practices

v) Role of women

vi) Other descriptions

Social Acceptability Evaluation

Ø Make checklist of acceptability indicators.

Ø Prepare comprehensive forms of technologies applicable to bigger areas.

Ø Input availability by group purchasing of inputs or sale of products.

Ø Group marketing of products.

Ø Expansion of market by incorporation of agribusiness.

Ø Potential technologies should be categorized based on government support consideration.

Ø Address problems related with government policies.

Improved systems should be evaluated by adoption indices by individual farming families and other neighboring farm families potential. Suitable improved practices may be evaluated by three criteria.

i) Technical element

ii) Exogenous factor

iii) Indogenous factor

Suitability can be assessed in an ex-post sense through various methods of acceptance such as adoption indices. The willingness to adopt a particular technology will be partially determined by ability to do so. The prices to the inputs and market for product produced will affect willingness to adopt are critical issue.

The condition for adoption may depend on following.

i) Technical feasibility

ii) Social acceptability

iii) Compatibility with external institutions or support system.

The improved practices must be compatible with the goals of the potential adopter. Usually food self sufficiency is the first goal then profit maximization.

Profitability should be consider by both self consumption and its price during consumption and sale of the produce. If the desire is for food self sufficiency then avoid risk by ensuring dependability of return from an innovative criterion. If the improved practices can be proved to be more profitable and as dependable as those they replace, they are likely to be attractive to farming families.

2. Farming Systems Research and Development (FSRD) Policy Guidelines

Farming Systems Approach is the major thrust of NARS for achieving its goal to provide technologies to sustained increased farm productivity.

2.1 **Concept** - what farmers do under a given set of farming condition should be called Farming Systems. When total research efforts are geared to a systems approach should be called Farming Systems Research (FSR).

Farming Systems Approach involves farmers, agricultural extension workers and researchers coming together on-farms to identify farmers problems/needs and to determine research priorities. The goal of FSRD should be to generate appropriate technology in farmers' fields which should be technically feasible, economically viable and socio-culturally acceptable.

2.2 Characteristics of FSRD

FSRD should be holistic in outlook and should be both multi and interdisciplinary. FSRD approach should be farmer based, problem solving, comprehensive, interdisciplinary, complementary, interactive, dynamic and socially responsible. FSRD in a specific location may include one or two or several subsystems depending upon the needs of farmers, potential available technology and facilities available. FSRD should target small farmers as the clients for agricultural research and technology development. Interaction of farmers and technology should be major focus of FSRD.

2.3 Frame Work of FSRD Methodology :

In diagnostic stage systems analysis should be undertaken to understand farmers problems and opportunities in the farms, villages, districts, and region by rapid rural appraisal. Causes of problem, interaction with other problems, and relative importance of the problem in the farming systems in target area should be determined by analysis of agroecology, socioeconomic, gender issue and agribusiness factors.

The goal of the design stage should be to screen existing technologies to solve target problems and formulate improved production technologies.

Ex-ante analysis should be used to design improved production technologies by multidisciplinary scientists to conduct interdisciplinary research.

The following program area should get priority while designing research program.

Crops - homestead farming systems.

Crops - homestead - livestock farming systems.

Crops - homestead - livestock - fisheries farming systems.

Crops - homestead - livestock - fisheries - agroforestry farming systems.

Socio-economic should be part of each system.

The goal of the testing stage should be to evaluate experimental technologies on-farm under farmers management and determine adaptability throughout the recommendation domain through multilocation testing, pilot production program and first line demonstration by increasing extension involvement. The adoption of technology by individual farming family and society should be major criteria for evaluation of suitability or relevance of the technology.

2.4 Management

Over all guidance will be provided by National Technical Committee headed by EVC BARC. Each participating institution should form a task force representing from various disciplines. The institute project coordinator should overview program planning, integration, operation, and inter-institutional coordination.

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SITE SELECTION FOR SYSTEMS RESEARCH

Pradip Ranjan Kar

FARMING SYSTEMS RESEARCH SITE

A FSR site is the geographical area in which the research team design and tests alternative farming systems.

CRITERIA FOR SITE SELECTION

1) The site must be representative of large target area in terms of farming systems environment.

2) The site must have potentials for development.

3) The site should be a priority development area.

4) The site should have adequate infrastructure to support improved production-consumption systems.

5) The site must have adequate accessibility.

6) The area must be suitable for establishing a site office and the research staff can live in the locality without under hardship.

7) The site should preferably located near to the existing research station, if any.

NATURE OF FSR

FSR addresses itself of each of the farm enterprises and to the enterprises and to the interrelationships among them and between the farm and its environment. The research is site specific and it uses information about the farm's various production and consumption systems- the cropping systems, animal production systems etc. and the secondary production activities that add value to the primary products. It also uses information of farm environment (biophysical, institutional, physical,social, economic) to identify ways to increase efficiency which the farm uses its resources.

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* Source : FSR manual of IRRI and BARI.

STEPS IN SELECTING A SITE

Step 1. Understanding the existing farming environment of the area by different parameters using the information form, secondary sources and reconnaissance surveys.

Step 2. Making extensive travel throughout the target area, observing the area physically by the research team, and discussing with key informant people to reinforce the understanding of the existing farming environmental components.

Step 3. By way of traveling, choosing 2-3 alternative sites each spreadi prevailing farming systems environment.

Step 4. Making comparative studies of the alternative sites in terms of prevailing farming systems environment.

Step 5. Selecting one site finally which has all the major varied situations occurring within the broader target area in consultation with the senior FSR scientists and experienced extension and soil survey personnel.

SITE RESEARCH TEAM

The group of scientists working at the FSR site.

REQUIREMENTS OF THE RESEARCH TEAM

1. A strong multidisciplinary unit.
2. Able to identify environmental complexes, FS determinants, constraint and potentials.
3. Trained in farm survey methods to determine farm resource base and to identify the existing management practices and their relation to important environmental factors.
4. Able to plan and execute experiments, analyse them and interpret results.
5. Dependable sources of information about farm level production technologies and the performance of technical innovations in the site.
6. Willing to accept and extend cooperation.

ROLE OF THE SITE RESEARCH TEAM

1. Selection of research site considering the site selection criteria.

2. Collect secondary information for site description.

3. Conduct initial studies to generate information for describing existing farming systems.

4. Identification and description of farming systems determinants and different production methods/ technologies related to various farming systems enterprises and associating them with the variations in the environmental complexes.

5. Identification of constraints and potentials for FSR development of existing FS.

6. Design of research (alternative systems/methods) for the improvement of existing FS.

7. Testing alternatives at the site and within target area.

8. Maintaining linkage with back-up research and extension services for feed-back.

9. Evaluate research results.

10. Formulate/draft tentative recommendations.

SITE COORDINATOR

A senior team member, usually SSO, who coordinates the site research activities and provide logistic support for the team.

ROLE OF SITE COORDINATOR

1. Acting as the site team leader.

2. Coordinating the research activities of the site.

3. Providing logistics to the team.

4. Providing technical supervision.

5. Working actively for certain research program.

6. Maintain linkage with back-up research of various disciplines, extension services and other relevant organizations.

SELECTION FOR TARGET AREA AND SUB-AREA

A Farming Systems Research and Development target area may be select for three basic reasons:

(1) to meet the needs of the people there;

(2) to take advantage of the potential for increased agricultural production;

(3) or to meet broader research or policy objectives such as the development of methods of controlling erosion which can be applied to watershed areas throughout the country.

PUTING TOGETHER THE FSR/E TEAM : INTERDISCIPLINARY INTERACTION

Definitions

Multidiscplinary: Involving scientists from several disciplines but the effort is planned, executed, and evaluated by each personal separately.

Interdisciplinary: Involving input from several disciplines and with the effort mutually planned, executed and evaluated.

WHAT ARE THE CHARACTERISTICS OF AN EFFECTIVE INTERDISCIPLINARY TEAM ?

The essential components are :

- a core of competent, dedicated and agreeable team members;
- fleshed out by adaptive and balanced leadership;
- held together and enhanced by collaborative team work and frequent communication;
- and supported by an institutional framework that understands and rewards the extra time, effort and costs associated with successful interdisciplinary.

AGROECOLOGICAL ZONING (AEZ) OF BANGLADESH

Dr. Md. Muslem Uddin Miah

Background

Bangladesh possesses a wealth of information on natural resources relevant for agricultural development planning. Rainfall records for a number of stations date back as far as 1900-1910, and temperature and other climatic records are available for some stations from 1947. A reconnaissance soil survey carried out between 1963 and 1975 provided comprehensive information on soils, land levels in relation to seasonal inundation and land use, together with interpretations in terms of land capability and crop suitability.

The Land Resources Appraisal of Bangladesh was initiated in 1979 under the FAO/UNDP Land Use Adviser Project. The objective was to set up a natural resources data bank for an assessment of the areas suitable for the production of a range of strategic crops.

Importance

The seven reports comprise the Land Resources Appraisal of Bangladesh that contain the following main kinds of information :

- Summary
- Agro-ecological regions of Bangladesh
- Land resources data base
- Hydroclimatic resources
- Land resources
- Land suitability assessment
- System documentation and processing

These reports are designed to assist four main kinds of user :

a) National and regional development planners in identifying and assessing areas suitable for specific crops or modes of agricultural development.

b) Agricultural and forestry research scientists in determining regional research priorities and in comparing the results of research trials on an agro-ecological basis.

c) Agricultural and forestry production and extension planners in preparing area-specific extension and demonstration programmes and in assessing results on an agro-ecological basis.

d) University and college teachers, students and researchers in gaining access to a comprehensive and up-to-date data base and appraisal of the country's physiographic, soil, inundation (flooding) and climatic resources.

Bangladesh's Agro-ecological Resources

Bangladesh includes a wide range of environmental conditions. Environmental diversity occurs not only at national and regional levels. It occurs also at Upazila and Village levels. In fact, small scale complexity of soil and hydrological conditions is an important characteristic of Bangladesh's environment.

An agro-ecological zone is a zone which has a unique combination of physiographic, soil, hydrological and agroclimatic characteristics. Overlay of the agro-climatic inventory on the physiography and soil map produces agro-ecological zones. There are 30 agro-ecological zones and 88 sub-zones in Bangladesh.

Thirty agro-ecological regions and 88 sub-regions were created by adding successive layers of information on the physical environment which are relevant for land use and for assessing agricultural potential. These layers are :

- land forms;
- soils;
- inundation regime;
- climate

Information on each of these parameters has been inventoried in the BARC computer centre on an Upazila, District and country basis.

1. Landforms or physiography

Physiography is the combination of geological material in which a particular kinds of soil have formed and the landscape on which they occur. It is the primary element in defining and delineating the agro-ecological regions of Bangladesh. Thirty four physiographic units and submits have been recognized in Bangladesh (Table 1). These units have been grouped into 30 AEZ regions. Floodplain and piedmont plain units occupy almost 80 percent of the land area. Slightly uplifted fault blocks (referred to as terraces) occupy about 8 percent. Hills occupy about 12 percent.

2. Soil

Soils form the second element in defining and differentiating agroecological regions. Soil conditions determine such important properties for plant growth as moisture supply and root aeration as well as nutrient supply. Twenty one General Soil Types, 102 FAO/UNESCO units, USDA soil Taxonomy and parent material of 574 soil series have been considered in defining AEZ units.

The General Soil Types are differentiated into three physiographic groups : floodplain soils; terrace soils and hill soils. Floodplain Soils have formed in alluvial sediments ranging from a few month to several thousand years in age. The agricultural potential of floodplain soils determined by hydrology - depth and duration of seasonal inundation. Availability of water for irrigation has become increasingly important in determining cropping patterns, productivity and potential in recent years.

Terrace Soils comprise a wide range of soils formed over the Madhupur elay. Fertility of this soil is generally low. Irrigation and adequate fertilizer use are the main requirements.

Hills Soils include a wide range of soils formed over consolidated and unconsolidated sand stones, siltstoms and shales which underlie the Northern and Eastern Hills. Agricultural potential is severely limited by the prevalent steep slopes, heavy monsoon rainfall and the associated erosion hazard. Forestry and tree crop production are the most appropriate forms of land use.

3. Inundation land types

On most floodplain and valley land cropping patterns are primarily determined by the seasonal flooding regime : i.e. the dates when inundation begins and ends, the depth of inundation at peak levels and the risk of damage to crops by early, high or late floods. Farmer's traditional cropping patterns and practices are adapted to flooding regimes on a microtopographical scale differences of only a few centimeters between neighbouring fields may influence choice of crop or varieties, or management practices.

Seasonal flooding regimes have been characterised by means of inundation land types, defined as follows :

HIGHLAND (H) : Land which is flooded less than 30 cm during flood season.

MEDIUM HIGHLAND (MH) : Land which is flooded between 30 cm to 90 cm during flood season.

MEDIUM LOWLAND (ML) : Land which is flooded between 90 cm to 180 cm during flood season.

LOWLAND (L) : Land which is flooded greater than 180 cm during flood season.

VERY LOWLAND (VL) : Land which is flooded greater than 180 cm during flood season (B.Aman can not be grown).

BOTTOM LAND : The land which remains waterlogged pereniallly. This type of land can be any land type in between lowland and very lowland.

4. Climate

Available climatic data for 30 principal stations of BMD and for 177 rainfall stations of BWDB were compiled, reviewed and analyzed for the land resources appraisal. An historical analyses of the climatic data was carried out in order to characterise moisture and thermal regimes, including year to year variability.

In Bangladesh temperature is favourable for growing crops throughout the year. Available soil moisture storage determines the length of growing period.

Quantification of the moisture regime has been achieved in a reference manner using a water balance model relating precipitation to potential evapotranspiration. This model was used to compute reference length of pre-kharif, kharif and rabi growing periods under rainfed conditions. For production of dryland crops, a soil moisture supply rate from a combination of rainfall plus soil moisture storage of greater than half the potential evapotranspiration rate is considered potentially suitable for crop establishment and early growth. In the kharif growing period, moisture characteristics are primarily determined by rainfall, but they are modified by seasonal inundation on some floodplain land. In the rabi season, moisture characteristics are mainly determined by soil moisture storage after the end of the rainy season. For the kharif growing period, a reference soil moisture level of 100 mm is assumed, for the rabi growing period, 250 mm of soil moisture is assumed.

Moisture zones are of two kinds : Pre-kharif transition period (p zones) and kharif growing period (k zones). In Bangladesh, six pre-kharif transition zones have been recognized (PI-P6). The zone P1 covers Sylhet and north-east of Sunamganj districts. The zone have mean length of 10-20 days starting on 17 March, ending on 2 April. The total number of dry day's when

precipitation falls below 0.5 PET ranges from 1-9 days. Zone P6 covers west of Jessore and Satkhira districts. This zone has mean length of 60-70 days, starting on 17 March, ending on 21 May. The total number of dry days range from 39-48 days.

Kharif growing period (K 100) is the period when precipitation plus soil moisture storage is sufficient to grow kharif crops without irrigation. It starts on the date when precipitation exceeds 0.5 PET and ends on the date when precipitation plus assumed 100 mm of stored soil moisture falls below 0.5 PET. In Bangladesh 12 reference kharif growing periods have been recognized (K1-K12). The period ranges from 170-180 days (K1) in extreme west to 280-290 days (K 12) in extreme north-east. This wide variability has important agricultural implications.

Thermal Zones

Thermal Zones are of two kinds : cool winter period of rabi temperature zones (T) and extremely high summer temperature zones (E).

Rabi Temperature Zones

Five zones have been identified (T1-T5) depending on the length of the cool winter period. The mean length of the cool winter period increases from 30-40 days on the coastal area to about three months in the north-west and north-east. The cool temperature zones indicate important agricultural implications for the cultivation of rabi crops and boro. The climate of north-western part of the country is most suitable for the cultivation of wheat, potato and rabi pulses.

Extreme summer temperature zones indicate the average number of days per year when maximum temperature exceeds above 40°C. Four zones have been recognized (E1-E4). The zone with 10-15 days in a year with temperature exceeding 40°C occur in the west of the country where the length of the growing season is shortest and the frequency of dry breaks is greatest. These extremely high temperatures usually occur in April - May and occasionally in early June.

Land Suitability Assessment

The Bangladesh Agro-ecological zones programme set up in the BARC Computer Centre is designed to provide a national system of data base management and land suitability assessments to serve the needs of agricultural research, extension and development planners at national, regional and local levels. The system is capable of being continually updated and extended.

The procedure for assessing land suitability for individual crops involves successive steps to :

- ecological requirements and limitations of crops under specified production systems,
- assess the agroclimatic suitability for each crops,
- assess the suitability of individual soils for each crops,
- combine the agro-climatic and soil suitability classification to provide land suitability classes for each crops,
- match the ecological suitability classification for each crop against the data included in the computerized land resources inventory so as to obtain the area of land in each land suitability class by Upazila, District, Country agro-climatic zone.

Five suitability classes are :

Very suitable (VS)	:	80 percent or more of maximum attainable yield (MAT)
Suitable (S)	:	60-80 percent of MAT
Moderatity suitable (MS)	:	40-60 percent of MAT
Marginally suitable (mS)	:	20-40 percent of MAT
Not suitable (NS)	:	less than 20 percent of MAT

The results of the land suitability assessments made for 48 crops are available as computer printout files at BARC Computer Centre.

Table 1 Physiographic Units

No.		Symbol*	Name	Area (in sq.km)
1		Ph	Old Himalyan Piedmont Plain	4 008
2		-	Tista Floodplain	10 304
	2a	Ta	- Active Tista Floodplain	(836)
	2b	Tm	- Tista Meander Floodplain	(9 468)
3		Kb	Karatoya-Bangali Floodplain	2 572
4		Al	Lower Atrai Basin	851
5		Pl	Lower Purnabhaba Floodplain	129
6		-	Brahmaputra Floodplain	16 344
	6a	Ba	- Active Brahmaputra-Jamuna Floodplain	(3 190)
	6b	By	- Young Brahmaputra and Jamuna Floodplains	(3 924)
	6c	Bo	- Old Brahmaputra Floodplain	(7 230)
7		-	Ganges River Floodplain	24 508
	7a	Ga	- Active Ganges Floodplain	(3 335)
	7b	Gh	- High Ganges River Floodplain	(13 205)
	7c	Gl	- Low Ganges River Floodplain	(7 968)
8		-	Ganges Tidal Floodplain	17 066
	8a	Gn	- Ganges Tidal Floodplain (non-saline)	(5 238)
	8b	Gs	- Ganges Tidal Floodplain (saline)	(6 258)
	bc	Gm	- Ganges Tidal Floodplain (Sunderbans)	(5 570)
9		Gb	Gopalganj - Khulna Bils	2 247
10		Ab	Arial Bil	144
11		-	Meghna River Floodplain	2 464
	11a	Mm	- Middle Meghna River Floodplain	(1 555)
	11b	Ml	- Lower Meghna River Floodplain	(909)
12		-	Meghna Estuarine Floodplain	17 011
	12a	Mn	- Young Meghna Estuarine Floodplain (non-saline)	(2 136)
	12b	Ms	- Young Meghna Estuarine Floodplain (saline)	(7 135)
	12c	Mo	- Old Meghna Estuarine Floodplain	(7 740)
13		-	Surma-Kusiyara Floodplain	9 195
	13a	Se	- Eastern Surma-Kusiyara Floodplain	(4 622)
	13b	Sb	- Sylhet Basin	(4 573)
14		Pn	Northern and Eastern Piedmont Plains	4 038
15		Cc	Chittagong Coastal Plain	3 720
16		Ci	St Martin's Coral Island	8
17		-	Barind Tract	7 727
	17a	Bl	- Level Barind Tract	(5 048)
	17b	Bn	- North-eastern Barind Tract	(1 079)
	17c	Bd	- High Barind Tract	(1 600)
18		Mt	Madhupur Tract	4 244
19		-	Northern and Eastern Hills	18 172
	19a	Hh	- High Hill Ranges	(10 944)
	19b	Hl	- Low Hills	(7 228)
20		Ha	Akhaura Terrace	133

* These symbols are used in the mapping unit symbols on the Land Resources Inventory map accompanying report 5.

FORMAL SURVEYS USED IN FSR

Dr. S. M. Elias

NARROWLY FOCUSED FORMAL SURVEY

** General hypothesis developed through informal survey can be refined and expressed more precisely through formal survey.

** It uses structured questionnaire.

** Follow statistical methods to be representative.

** Develop more quantitative data.

** Make significant contribution towards improving the quality of information based upon which Development Policies and Biological Research Priorities are formulated.

REVIEW OF LITERATURE TO

* Determine what research have been done.

* Avoid any duplication of research.

* More carefully focus on important issues which have been neglected previously.

* Avoid some of the methodological weakness which may characterize earlier studies.

SECONDARY DATA HELPS TO

* Provide an overview of general agril. situation.

* Take decision whether a survey is actually necessary or not. Survey is only a means to an end and not an end in itself.

KEY TO INFORMANT SURVEY

Farmer

Non farmer

EXPLORATORY SURVEY

Quickly gather information through informal interviews with many people and farmers, in order to arrive at a tentative description of farmer practices as well as understanding of why farmer follows those practices.

RAPID RURAL APPRAISAL

Quick informal farmer survey and uses of secondary data to identify :

** Present situation

** Development potentials

** Constraints

** Need

DATA COLLECTION TECHNIQUES FOR PROBLEM IDENTIFICATION

* Previous studies

* Secondary data

* Site reconnaissance/direct observation

* Direct measurement

* Key informant survey

* Rapid rural appraisal

* Exploratory survey

* Informal farmer survey

* Group interviews

* Narrowly focused formal survey

SUPERIMPOSED TRIALS

** Superimpose of farmers practice over experiments.

** Not good estimates.

MARGINAL CHANGES

** Estimates are made by trying to determine the difference in requirements between experiments and farmers practice.

LABOUR AND POWER STANDARDS

Secondary Data

Farmers Practice Interview

** Uses narrowly focused formal survey.

KEY INFORMANT SURVEY

Crops Cuts

Parcel Measurements

OBSERVATION (STOP WATCH)

** Most accurate data on labor and power

** Difficult when farmers are irregular

** Depends on farmers availability of time

OBSERVATION + MULTIPLE VISIT SURVEY

One Time Crop Interview

** Uses narrowly focused formal survey

YEARLY FARM INTERVIEW

** Uses long formal farmer survey

SMALL PLOT COMPARISONS

** Different for labor and power data.

SECONDARY AND PRIMARY CROP COMPARISON

** Using short formal survey, gain farmers assessment of the labor needs of two major crops.

** Useful for ex-ante analysis for design.

DATA COLLECTION TECHNIQUES FOR EVALUATING CROPPING PATTERN TRIALS

WHOLE FARM RECORD KEEPING

** Assess on-farm technical feasibility and economic viability

** Develops better understanding of farming systems

** Provide data for development of farm models

ENTERPRISE RECORD KEEPING

** Focus more on specific enterprise

PARCEL RECORD KEEPING

** Focus more on particular parcel

MULTIPLE VISIT SURVEY

** Useful technique where,
- Recall of data is a problem
- Farmers are illiterate

** Visit daily/twice in a week/weekly or once in two weeks.

MAJOR CATEGORIES OF DATA NEEDED FOR EVALUATING CROPPING PATTERN TRIAL

Cropping Pattern Trial	Farmers Cropping Pattern
* Labour inputs	* Labour inputs
* Power inputs	* Power inputs
* Material inputs	* Material inputs
* Prices, cost, wages, interest rate	* Prices, cost, wages, interest rate
* Parcel or plot size	* Parcel size

GATHERING INFORMATION FOR FSR : CHOOSING METHODS THAT WORK

Dr. Sahadad Hossain

WHAT WE NEED TO KNOW ?

* Physical
* Biological
* Socio-economic

TO UNDERSTAND

* What farmers are doing ?
* How they are doing ?
* Why they are doing ?

RESEARCHERS IDENTIFY

* Factors that influence farmers' choice of farming system.
* Factors to be considered for improved farming systems.
* Immediate and long term problems both endogenous and exogenous.
* Cooperator farmer and clientele groups.
* Goals, preference, priorities and decision making process.

INFORMATION (DATA) NEEDED ON

Ø The natural circumstances.

Ø The external socio-economic circumstance.

Ø Farm household socio cultural characteristics.

Ø Farm household resource availability.

Ø Farm household enterprises.

Ø Crop production practices.

Ø Farming system interaction.

Ø Constraints to higher yield.

Ø Opportunities and priorities for research.

Ø Community level variables on employment, tax income, school, health infrastructure, nutrition status, etc.

PRIMARY DATA COLLECTION INSTRUMENT

A. Village leader interview.

B. Group interview.

C. Structured individual interview.

D. Farm record keeping.

E. Verification measurement.

A. VILLAGE LEADER INTERVIEW

ADVANTAGE :

Ø Effective tool to rapidly gaining an overall impression of the village.

Ø Help access to the villagers.

Ø Orient researchers to the area.

Ø Can get available secondary data.

Ø Has broader world view than common villages.

Ø Help to design on individual farmer survey.

DISADVANTAGES :

Ø May provide biased answer.

Ø Data may fail to identify variability in farming situation.

Ø Requires skilled enumerators.

Ø Difficult to compare the answer given by each respondent.

B. GROUP INTERVIEW

Ø Selected 5-10 villagers in a group and administers an unstructured questionnaire.

Ø Set of questions should guide the discussion but not restrict it.

Ø Questions should be those applicable to all or majority.

ADVANTAGES

Ø Effective way to develop the appropriate response categories necessary in designing a preceded individual interview.

Ø Facilitate the development of a lively debate which helps to go insight into the issue.

Ø Village specific data can be collected rapidly.

DISADVANTAGES

Ø Hesitate to open mouth of sensitive issue.

Ø Competence of the farmer can not be measured.

Ø Difficult to superior to village leader interview.

Ø Group interview is superior to village leader interview.

C. STRUCTURED INDIVIDUAL INTERVIEW

Ø Use structured questionnaire.

Ø Specific critical issues are further investigated.

Ø General hypotheses can be refined and processed.

Ø Used on sample of farmers.

a. THE PRE-TEST OF INTERVIEW

Ø Tests validity of the questions.

Ø Test structure of the questionnaire.

Ø Test ordering of questions.

b. FARMER INTERVIEW

Ø Enumerator isolates the sampled farmer and asks a set of structure questions.

ADVANTAGES

Ø Respondents are not influenced by others.

Ø Response variability can be measured.

Ø Provide quantitative data rather than qualitative.

Ø Statistical analysis of data is possible.

Ø Experience required may be less than earlier on.

DISADVANTAGES

Ø Difficult to isolate the respondent from others.

Ø Presence of others may influence him.

Ø Due to lack of capability of enumerators respondents may answer differently.

Ø Time consuming and expensive.

Ø Timeliness is critical for obtaining correct answers.

D. FARM RECORD KEEPING

* Fixed set of questions are asked during each meeting with farmer.

* Used mostly where very accurate detail information is required.

* When continuous non-registered data required.

ADVANTAGES

Ø Minimize elapsed time between the period when activity is completed and when it recorded.

Ø Provide very accurate data.

Ø Enumerators can clarify any suspicious or gain confidence through visits many times to the farmers.

Ø Any confusion whenever arises, can be clarified in the next visit.

DISADVANTAGES

Ø Takes longer time - at least a season.

Ø Very costly.

Ø Super vision is necessary.

VERIFICATION MEASUREMENT

* By this method farmers answer is verified to increase the accuracy of data.

1. PHYSICAL MEASUREMENT

- Physically measurement can be done

  Ø Land/percale for area.

  Ø Crop cut for yield.

2. TIME MEASUREMENT

Ø Measurement of time of field operation.

Ø It may be biased, because if farmer know that he is being timed he may worked faster than normal.

Ø It is appropriate when the greatest degree of accuracy is required.

3. FARMERS FIELD EXPERIMENT

Ø Conduct simple experiment in the farmers field for potential of a given technology.

Ø It requires high technical knowledge and supervision.

F. CHOOSING APPROPRIATE PRIMARY DATA COLLECTED INSTRUMENT

Ø In situation where only general informations is required, village leader or group interview may be adequate.

Ø To refine general hypothesis into specific hypothesis individual narrowly focused formal survey is required. But it should be proceeded by informal group interview or village leader interview.

- Farm record keeping is necessary if continuous non registered data is needed.

- Verification measurements are most applicable to surveys and farm record research which place a high value on accurate measures of area, output, labour input and technology potential.

- Depending on the research goal and purpose, one or all of the strategies can be used.

QUICK FSR SITE DESCRIPTION

Mrinal K. Chowdhury

There are four stages in farming system research (FSR) (Fig. 1). These are :

a) Diagnostic or descriptive stage

b) Design stage

c) Testing stage.

d) Dissemination or extension stage

In the diagnostic stage the actual farming system is examined in the context of the total environment to identify constraints farmers face and to ascertain the potential flexibility in the farming system in terms of timing, slack resources, etc. An effort is also made to understand goals and motivation of farmers that may affect their efforts to improve the farming system (Norman, 1982). Thus, the purpose of site description can be :

i) to have a better understanding of existing farming systems or farmers' circumstances;

ii) to have benchmark or baseline information of an FSR site;

iii) to identify farmers' problems in order to design improved technologies for testing to overcome the problems;

iv) to identify useful and superior farmers' practices;

v) to have a basis for choosing cooperator farmers, and

vi) to identify extrapolation areas.

The data requirements for meeting these objectives overlap but there are differences in how critical the timing and speed in data collection and analysis is (van Der Veen, 1986a).

Understanding the farmers' situation

There are three major aspects of the farmers' situation which should be considered during site description :

Ø understanding the farmers' environment;

Ø describing the existing farming system, and

Ø analysis of the existing farming system.

A good description of farmers' environment and the farming system is necessary to identify a group of farmers operating within similar environmental conditions sharing similar problems and opportunities (Shaner et. all, 1982). In describing an FSR site a distinction should be made between :

a) environmental factors over which the farm household has little control, and

b) farm management factors over which the farm household has considerable control.

Improvement in existing systems are usually made by manipulating the latter.

Farmer's environment

The farmers' environment can be divided into physical, biological, economic and social settings (Shaner et. al., 1982).

The more important physical factors are climate, water and land. Temperature and rainfall, recorded at the nearest weather station should be used. For temperature, the average monthly values and the maximum and minimum temperature during critical periods in the growing season are important. Rainfall analysis should include monthly average, variability and the beginning and ending of the rainy season. What type of irrigation facilities are available should be recorded. The location, slope, soil type, chemical properties should also be taken into account.

The biological settings include those factors that influence the health and vitality of plants and animals, and the utility of harvested products. Among these are : plant and animal diseases, and insects, stored grain pests, weeds, rodents and birds.

Economic settings that influence the farming systems include price of inputs and outputs, access to market at critical periods, storage, transportation and credit facilities. Other aspects like processing facilities of farm products, extension service, cooperatives, labour supply and wage rates are also very important.

The FSR team should also consider the social settings in describing farmers' environment because these factors influence the acceptance of new technologies. These include social norms and customs as they relate to land ownership and use, division of labour, rights and obligations according to sex and age groups etc.

Description of existing farming systems

Farming system is a unique and reasonably stable arrangement of farming enterprises that the farm household manages according to well-defined practices in response to the physical, biological, and socio-economic environments and in accordance with the household's goals, preferences, and resources.

In describing the farming system we should consider the household, its resources and farm enterprises.

The farm household or the family is the key element in farming systems. The team should consider the type of family, farmers' sex, age, education, literacy and ethnic background; his knowledge related to alternative management practices, cropping patterns, sources of inputs, agricultural information and markets; his beliefs, attitudes and past behaviour; and his goals what the family desires.

Household resources include land, labour, capital, management and farm enterprises. Size of holding, ownership, tenancy, and land quality, water availability and location are important land characteristics. The availability of family labour by age and sex, specialization, and participation in cooperative efforts are to be considered. Household's capital refers to physical and financial assets including tools and equipments, livestock, trees, access to credit etc.

Farmers combine various enterprises like crops, livestock, fisheries, off-farm employment etc. to meet their needs. The FSR team should look into the general agricultural practices, principal crops and cropping patterns, type of livestock and livestock practices, interactions between different enterprises, overall cash, labour and power requirements, inputs that are purchased and disposal of farm products.

The details necessary for description of farming system are available in Zandstra et.al. (1980) and Shaner et al. (1982).

Analysis of the existing farming systems

Mere description of farming system is not enough. The FSR team should analyze the existing farming systems to understand the interrelationships among the components of the system. Simple conceptual models can be developed to classify the enterprises and show the relationships. Developing conceptual models will help the FSR teams to develop also meaningful hypothesis for understanding and improving the farming system.

Analysis of problems and opportunities

The FSR team should select farms representative of the prevailing farming systems and see how well they compare with other farming systems. If the performance of an enterprise of the representative farmer is poorer that other farmers, then it may be considered a problem. But before identifying something as a problem, the team should understand why the farmer is following the practice. Because this can be a purposeful decision to mitigate a more serious problem.

The topic of identifying farmers problems and setting priorities for problems and opportunities will be considered in detail in some other lectures.

Data collection methods

The methods of data collection to be used in FSR are determined by the following factors (Shaner et. al., 1982) :

Ø the character of the FSR activities;

Ø the stage in the FS process at which data collection takes place;

Ø the amount of detail and degree of accuracy considered necessary;

Ø the size of the data base needed;

Ø the resources (e.g. money, time, personnel, equipment etc.) available for data collection and analysis.

Two types of data are collected for site description : secondary data and primary data.

Secondary data

For some types of information, using secondary sources is the most efficient method of data collection. Secondary sources may provide good information on physical factors such as rainfall patterns, soil types, etc. But secondary data are usually inadequate on socio-economic and biological aspects of the farming systems. However, primary data collection should always be done after reviewing the available secondary data.

The usefulness of secondary data can be determined by the following four criteria :

- the relevancey and specificity of the data for the particular study;

- the clarity of defined terms. For example, data on "cost" should clearly indicate whether they mean total cost of production;
- the accuracy and reliability of data. Cross checking of data from different sources is necessary; spot surveys are useful;
- the recency of data. Socio-economic data that are more than 10 years old may not be relevant any more. On the other hand, long-term climatic data are sometimes necessary and useful.

Primary data

There are several methods of primary data collection. However, these methods fall into two major categories informal and formal.

The informal methods include :

- exploratory or reconnaissance surveys,
- informal follow-up observations and interviews, and
- participant observation

Formal data collection methods include :

- single interview surveys
- frequent interview surveys
    - farm record keeping
    - monitoring, and
    - case studies

Shaner et. al. (1982) and Van Der Veen (1986b) gave some details about the advantages and disadvantages of the above methods and how to conduct them. There will also be detail discussions about them later in this training. Each method is limited in the quality and type of information it can provide. Several methods should then be combined to increase the efficiency in data collection and accuracy of data.

A careful combination of data collection methods can complement each other and minimize their drawbacks. Shaner et. al. (1982) suggested the following possibilities :

- An exploratory survey should be followed by one or more of the other data collection methods.

- Informal observation and casual interviewing should accompany formal data collection methods.

- The single interview survey is often combined to good advantage with frequent interview surveys, farm record keeping, or case studies.

Finally, both secondary and primary data, informal as well as formal methods of data collection are important. In the early stages of FSR informal methods are generally preferred. They are more effective in establishing rapport between the research team and farmers, developing team cooperation, and providing the initial orientation for problem and opportunity identification, research and policy implementation. Gathering data by formal methods which give more systematic and quantifiable information, tend to become important in the later stages of research.

Formal surveys are expensive to carry out and is usually time consuming; frequently the analysis would require long time also. Therefore, the results are not available when needed. Considering these, informal survey methods like exploratory survey, sondeo, rapid rural appraisal, rapid assessment technique, etc. are now increasingly used for the purpose of site description.

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                                      /------ External <------\
                                      |       institutions    |
                                      V                       |
1.   Description or <-------- Existing farming                |
     diagnosis of    -------->    system                      |
     present farming                                          |
     system                                                   |
                                                              |
                                                              |
2.   Design of <------------  On-station <---- Body of        |
     improved --------------->  trials  -----> knowledge      |
     systems                                        |         |
                                                    |         |
                                                    |         |
                                                    |         |
3.   Testing of  <----------  On-farm   <---------  |         |
     improved    ----------->  trials  ----------->  |         |
     systems                                        |         |
                                                    |         |
                                                    |         |
4.   Extension of             Modified              |         |
     improved                 farming <------------/          |
     systems                  systems <-----------------------/
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Fig. 1. Schematic framework showing the stages of farming system research (adapted from Norman, 1982).

IDENTIFICATION AND PRIORITIZATION OF PROBLEMS IN FSR

Dr. Nizam Uddin Ahmed

Problem

A problem is the one due to which the productivity or any certain component or enterprise could not be achieved up to is maximum potential. In other words, a problem is something that directly affects the produtivity.

Identification of Problems

This can be dome by employing one or more of the ways of direct observation of the field/enterprise, interaction with the farmer either(s) on one is to one basis or through a group discussion, different forms of surveys, laboratory tests, review of secondary data or by doing exploratory or observational trials. Researchers must decide depending on their resources which one to be used. Usually a combination of more than one approach is good for problem identification.

In FSR , there exists several components or enterprises, viz, crop, livestock, agro-forestry, fisheries etc. In order to identify the problems of a farm of a recommendation domain, one have to start with an enterprise first and then follow one after another. The easiest way to identify the problems is to formulate a multidisciplinary researches group and to do a Rapid Rural Appraisal (RRA) or Sondeo in which the group visits the target area and talks to the farmers and tries to learn as much as possible about the target farms and the environments. While doing RRA, care should be taken that as much as information is gathered for all possible enterprised, and logical deductions are made based on field/ farm observation and researchers own understanding. Usually the major problems which are clearly understood or can seen are identified easily by this way.

For problems that are not easily understood or the causes could not be easily identified, further efforts are needed which could be one or more of the tools mentioned earlier.

While identifying the problems, their possible causes be also identified for effective identification of the reasonable solution. For some problems, the causes my be obvious, while for others more information must be obtained. Lack of care in defining the causes of a problem may limit the chances of identifying reasonable solutions. On the other hand, it is also not necessary to go to extreme in looking for causes. For example, the crop may be at risk of drought when planted late, and that late planting is in turn caused by a shortage of draft power. This is probably enough information as long as crop is

concerned. There is no need to go and get the statistics of the draft animals. The general practice is to get only enough information regarding the problem to enable researchers to think of practical solutions.

Problems in FSR can be prioritized for providing appropriate solution using the following criteria:

1. Seriousness of the problem

2. Availability of suitable technology

3. The cost of implementation of the required on farm research

4. The ease of implementation of the results

5. Government and/or policy makers priorities, and

6. farmers interests

The above criteria are discussed below in more details.

1. Seriousness of the problem

This could be of three dimensions, viz.

i) Severity : This relates to the degree of crop yield or net income is reduced due to the problem: 5, 50 or 100 percent.

ii) Frequency : This refers to how often for example in a 10 year period the problem occurs: once, twice or every year.

iii) General prevalence: This refers to how common the problem is, within the relevant part of the target area.

2. Availability of possible solution or suitable technology

A suitable technology should fulfill the following five criteria :

i) Biological feasibility

ii) Economic viability

iii) Technical feasibility

iv) Socio cultural acceptability,and

v) Resource compatibility

3. Research duration and cost

Farming system research projects generally have very limited budgets. On farm research requiring high levels of costs and relatively lengthy time for completion, receive lower priorities than low cost quick pay off research.

4. Ease of implementation

Relatively small or marginal changes in the farmers existing faring systems may be easier to implement than dramatic changes.

5. Government priorities

Each country's government probably has its own set of priorities for agril. research and these should be taken into account in making decisions for on farm trials.

6. Farmer's interest

Importance should be given for the objectives the farmers have for their production activities.

Farmers' feed back and opinions should play a large part in making decisions on research priorities for on farm trials.

DIAGNOSIS AND PRIORITAZATION OF RESEARCH PROBLEMS

Dr. S. M. Elias

Problem

a problem is a deviation from some standard of performance. A deviation from standard implies that some standard has been set, that some one has determined what the behaviour or level of performance should be.

Identification of a problem

A problem may be the result of one or several causes while one cause may result several problems. To specify a problem it is necessary to identify the cause - effect relationship of the problem.

An agricultural researchable problem may be identified from

1) Previous studies
2) Secondary data
3) Site reconnaissance and/or direct observation
4) Direct measurements
5) Key informant survey
   a) Farmer
   b) Non-farmer
6) Informal farmer survey
7) Group interviews
8) Narrowly focused formal farmer survey.

Survey may be informal or formal. Informal survey includes exploratory survey, rapid rural appraisal, group interview etc. It has the advantage of allowing the follow up on important topics by continued questioning. Therefore, the informal interview allows more indepth information to be collected and allows questioning on unanticipated but important subjects. It provides mainly qualitative data. On the other hand narrowly focused formal survey provides quantitative data which can be cross tabulated and which provides frequency estimates on farm characteristics in the location.

Exploratory survey

The essential objective of the exploratory survey is to quickly gather information through informal interviews with many people and particularly farmers, in order to arrive at a tentative description of farmer practices as well an understanding of why, in light of their particular circumstances farmers follow those practices. This information is useful in refining recommendation domains and identifying potentially improved technologies to overcome major factors limiting production and income.

The exploratory survey is carried out by multidisciplinary team of researchers through unstructured interviews with target farmers within the recommendation domain. The interviews are best conducted using the period when problem exists in the field. The discussion with the farmers represent a recursive learning process. Wherever possible, interviews are carried out in farmers fields, with visible evidence of farmers management before the researchers. These visits present an opportunity for researchers to interact with their clients as well as among themselves.

Recommendation domain

It is impossible to conducted experiment on each farm. Instead, a target group of farmers must be defined and make recommendations which and applicable to the entire group. Such group of farmers may be called recommendation domain. Generally a recommendation domain will consists of a group of homogeneous farmers within an agro-ecological zone with similar circumstances for whom more or less the same recommendation can be made. Both natural and socio-economic circumstances can form the recommendation domain.

Selection of research priorities

The data collected from the farmers through informal survey will have to be analysed to determine priority research area.

Situation analysis

The existing situation in the locality need to be analysed to decide on the recommendation domain, their farming practices, what and why they are doing. Particularly the farm size distribution, occupation, crops and cropping patterns, livestock position, fodder problems, fishery, trees, homestead utilization, soil test etc. are to be discussed to determine priority research area for farming system research.

Need analysis

Once the present situation of the farmer is known it is necessary to analyse his needs. The data collected through survey have to be analysed to specify.

a) Constraints to production - both biological and socio-economic,

b) Objectives of the farmers, their attitude, and

c) Availability of technology in relation to immediate problems to be solved.

Selection of production enterprise

Once the needs of the farmers are analysed, researchers will have to decide on which production enterprise, they will conduct research. A farmer may deal with several enterprises like crop, livestock, fishery, trees etc. He may have immense problems on one or few enterprises. But the researchers can not start doing research on all of his problems simultaneously. A researcher has to select priority on the basis of not only farmers problem but also availability of technology, his own resources etc.

However, experiments should be designed based on the farmers immediate problems for which technologies are available. Those problems for which improved technology is not available but are important should be designed to study at the research station or at farmers field very carefully. There are some socio-economic problems which are beyond the control of the researchers. It is necessary to be aware of them and keep in constant touch with the agencies working in the area.

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RESEARCH PLANNING WITH FARMING SYSTEMS APPROACH

R. N. Mallick

Research is defined as a systematic investigation of facts. It may be explained that the research is discovery of new knowledge, the extension of existing knowledge and application when application itself requires investigation. Agricultural Research covers institutional work seeking answers related to production, processing and marketing of agricultural products, increasing productivity, employment and income, and improving in general the quality of life of the farming population. It includes the packaging of research results in the form of technology and testing approaches to the transfer of such technology to the end users.

Research plan depends on goal to achieve. The goal of National Agricultural Research Systems (NARS) in Bangladesh is to provide technologies to sustain increased farm productivity. To attain this goal the approach used is **farming systems approach** which involves farmers, agricultural extension agents and researchers coming together on farms to identify problems and to determine research priorities. The goal will be attained by six programme areas : plant production systems, animal production systems, natural resource management systems, agricultural production support systems, agricultural policy support systems and agricultural information systems.

Agricultural Research Can Be Categorised In to Basic Research, Applied Research and Adaptive Research.

Basic research is easily transferable so international centers and universities play great role. To resolve a particular problem basic and applied both type of research may be utilized.

Adaptive research

Adaptive research is repetition of applied research under varied conditions e.g. development of specific variety of rice for Aus or Aman or Boro season, fertilizer recommendation for specific location or land type or soil type and so on.

Disciplinary Research

The process of approaching the object of study from the perspective of the particular discipline eg agronomy, economics, pathology and so on.

Commodity Oriented Research

The focusing of research on one or more crops or animals by studying them in considerable detail eg rice, jute, wheat, potato, poultry, duck etc.

On -Farm Research

The process of conducting research on farmers' fields influencing farmers.

Test Demonstration

Wide scale testing of adaptive research results. The high degree of variability in agriculture makes them an important process.

Operations Research

Research in to operation. A careful and scientific appraisal of a problem from all angles before a decision is arrived at. It is a tool of decision making.

What is Farming System ?

A farming system is a unique and reasonably stable arrangement of farming enterprises that a household manages according to well-defined practices in response to the physical, biological and socio-economic environments and in accordance with the households goals, preferences, and resources. These factors combine to influence both the output and production methods.

The farming system is part of the larger systems and can be divided into subsystems e.g. cropping, livestock, fisheries and household or homestead.

What is Farming Systems Research ?

Farming System Research is an approach to agricultural research and development that (1) views the whole farm as a system and (2) focuses on the interdependencies among the components under the control of members of the farm household and how these components interact with the physical biological and socio-economic factors not under the household's control. The approach involves selecting target areas and farmers, identifying problems and opportunities, designing and executing on-farm research and evaluating and implementing the results. In the process, opportunities for improving public policies and support systems affecting the target farmers are also considered.

Technology

Technology is the transformation of the acquired new knowledge to production.

Development

Refers stepwise processes involving increasing quantities and proceeds to the state of manufacturing. The most important part for application of the result of research is development.

Objective of Research

The objectives of research are to describe and explain why, and to generalize or extrapolate in similar conditions the findings of the experiment. The motive to conduct research is to attain goal, to solve problem and to maintain the system or to improve the system. Man, Money, Masonary and Materials - these 4 Ms are required for any successful research. Research proceeds till new product is developed. The most important part for application of the result of research is development.

Rapid Rural Appraisal

This form of diagnostic survey is conducted to understand existing farming systems, innovations, and to identify problems and constraints faced in farming, post-harvest operations, livestock, fish production, on-farm forestry etc. by different socio-economic groups.

The survey should be conducted by inter-disciplinary team consisting of agronomists, socio-economists and extension personnel of the area. If the site is to include livestock, fisheries, agroforestry etc. then researcher and extension personnels from those area should be included.

The team should visit and preferably live in the location for about 7-10 days. They should set questions relating to all farm activities and crucial problems being faced by rural people. The people to be interviewed should include labourers, farmers of different income groups, artisans, village traders etc. There will not be structured questionnaire but after visiting the site, the team should sit together and frame-out different questions that will be asked.

The objective of this diagnostic survey is to obtain information and a brief report so that the site team can agree on a definite programme of on-farm trials, special purpose surveys and communication methods for the first year. The survey findings will be the basis for planning the activities during the first year of the project.

Research Planning

PLAN

A plan is a predetermined course of action. Planning is defined as the act or process of making a plan which is termed as a programme, a project or a schedule. Purpose of planning is to evolve a sound, defensible and realistic course of action. Planning implies both a vision and a need. Vision of goals, ends, objectives, a possibility, desirable or real which are yet non-existent. The result of a planning process is a written programme to be implemented by the organization. Plan gives the detail answer to all pertinent questions involved in conducting a project.

In specific context to Bangladesh agricultural research, planning is done to cope with uncertainity, to minimize the variability of poor farmers to cope with loss; adaptation to heterogeneous settings; wide variety of technology choices to farmers and contingency planning for variability in weather and price.

Research Programme Should Have Following Characteristics

1. Clear and understandable.

2. Impact oriented and measurable.

3. Within nations development goals and mandate.

4. Within capabilities of resources.

5. Flexible and adjustable.

Planning Process

It is a process which involves identification of the problems, analysis of available data, definition of specific objectives; and development of results obtained. The task of planning is a continuous and dynamic process.

Planning cuts across all other functions of the organization, be that of organizing, directing, budgeting and so on. There are two types of plan; single use plan and long-term plan or strategic plan.

<u>Single Use Plans</u> - Single use or single purpose plans are those which have been designed to accomplish specific objectives usually within a relatively short span of time. Budgets, annual plan of work are single use plan.

Strategic Plans - These plans which are concerned with broad and wider scope of activities. These are designed to deal with relatively unpredictable economic and technological environmental factors.

The objectives and role of the institute should be clear while planning.

Steps in Planning

1. Identification of problem areas and determination of research priorities.

2. Planning of research projects and activities in line with the institutes objectives and research priorities.

In the first step of planning process the goal and objectives are established according to farmers need and national priority. The research approaches for achieving the objectives are determined. Each approach is then further developed by senior scientists. The scientists develops written materials that define the scope and scientific content of the approaches. Each research approach is organised in to one or more approach elements which contains in one more project areas.

A project area is defined as a significant block of scientific work needed to implement the approaches. Scientist should provide the following information for each approach elements and project area.

1. The nature of the problem to be solved and its scientific and agricultural importance.

2. Current research status and critical research needs or events or further progress.

3. The kind of results expected and the length of time needed to produce those results.

4. Potential benefits and impacts that can be expected if the research is successful.

5. Probability of successful achievement.

6. Relative priority of the research.

Strategy - Strategy is defined as a organization's way of coping with its environment. Strategic planning is a continuous process of making decisions that are based on the best information available for organizing people and resources to carryout those decisions and evaluating results against expectations. The basic task of research program planning is to identify those challenging opportunities and match them with the existing

research capabilities so that relevant contribution can be made towards solving the urgent problems of a growing society. The preparation of the research project proposal should be based on the problems encountered by farmers, programme planners and policy makers. The proposal should include information on the title of the project, objectives, procedures, duration of the project and budgetary requirements.

Stategies In Planning

1. Plan should cover a period of time.

2. Plan of action should be flexible.

3. From bottom to top levels of hierarchy should be involved in the planning process. Senior scientists give more time in planning due to their critical views and experience.

Process Of Formulation Of Strategy

1. Environmental and client analysis to identify the areas of opportunity.

2. Resource analysis to identify the available capabilities interms of manpower, equipment, land, laboratory and other facilities.

3. Value analysis for risks and rewards.

The result envisaged from planning is a written programme to be implemented by the organization.

Research planning strategies may be long-term, short-term, annual and contingency planning.

Research Process

The research process is the application of the method of science. Method means mode of working of the human mind. It goes through a logical sequence, selection and formulation of the problem, prioritization of problems. The problem may be prioritised on the basic of its frequency, severity and intensity. Then the research design may be done depending upon whether the research has to be done on-station, on-farm or on policy issues on macro or micro levels. The design of research is followed by implementation, monitoring, evaluation and communication.

Problem

A problem is a deviation from some standard of performance. Problem may be defined as result of constraints that prevent from reaching the goal. A problem may be the result of one or several causes of which one cause may result several problems. Cause may be defined as anything responsible for change, motion or action. Effect may be defined as anything brought about by a cause or agent. The production problem is a condition or situation created by a group of factors that limit the growth and productivity of plants or animals.

After identification of problem hypothesis has to be made to solve the problem. Hypothesis may be defined as predictive statement, capable of being tested by scientific methods, that relates an independent variable to some dependable variable. Hypothesis is an assumption or some supposition to be prove or disproved.

A working hypothesis is preliminary assumption based on few uncertain or obscure elements which is used provisionally as a guideline norm in the investigation. To solve problems multi-disciplinary or interdisciplinary or both type research are needed.

Multi-disciplinary research involves scientists from several disciplines but the effort is planned, executed and evaluated by each person separately.

Inter-disciplinary research involve inputs from several disciplines and with the effort mutually planned, executed and evaluated.

Research Approach

Research approaches are based on current scientific knowledge and will change as knowledge advances or as the research needs of agriculture change.

Top- Down Approach

The research proposals are initiated either by the programme leaders themselves or as per their directives on the basis of research ideas obtained from the researchers, extension workers and farmers.

The main approach used for research planning is top-down approach in NARS. In this approach the programme leader or his principle investigator identifies the problems, formulates the research proposals and discusses with task force and place before the Central Review Committee for approval and then implementation is done by the scientists concerned. Advance yield trial or study on biology of insect, genetic engineering and bio-technologies are some of the example of top-down approach. Most of the upstream research has top-down approach.

Bottom-Up Approach

In bottom-up research planning the problem identification is done at the grass root level and research proposal is initiated by the scientists working in close contact with the farmers.

The gap between farmers field and research station yield remained high inspite of large efforts made by NARS. The resource of the farmers are variable so they could not adapt modern technology as much as should have been. The outcome of the top-down research results could not full fill the desired level of farmers needs. This resulted to reorient research approach where the identification of the problems is done by interacting with farmers by researchers and extension workers.

The prioritization of the researchable problems are done by studying intensity, severity and frequency of problems. This is discussed in District and Regional Technical Committee meetings and research project is send to programme leader to discuss with Task Force which is comprised of divisional heads. Finally Central Programme Review Committee approves the program and implementation start at various levels. On-farm research division of BARI initiated, this since 1984 and process is followed to some extend by BARI & BRRI intensively and to some extend by other institution.

Top-down and bottom-up both approaches are supplements to each other. Most of the activities of bottom-up research is of down stream characteristics that is more site specific, primarily adaptive and useful without long delay for target group of farmers. Farming systems approch is bottom-up approach but more holistic in nature.

Project Planning

A project is a planned undertaking which is a set of inter-related and coordinated activities designed to achieve certain specific objectives within certain budget and the period of time. Project planning is preparation of projects embodying investment decisions for the implementation of sectorial programmes formulated under programme planning.

A project is a component of a program usually ranging from 1 to 3 years. It is a detailed statement of the work to be done by the scientists including objectives, variables and methodology with estimates of the time, personnel and facilities needed.

Research Planning System

National policy dictates research planning. Base on national policy central strategic plan is developed by BARC in collaboration of NARS scientists. This follows with institute operational plan and farm level project plan. To be specific for example on-farm research division of BARI has research program in farmers fields. OFRD has 10 research projects viz improvement of cropping systems, crop livestock interaction, agro-forestry system, homestead system and so on.

Planning Cycle

It starts with awareness then problem identification, objectives, assumptions, analysis of facts, identification and evaluation of alternates, decision, task assignments and implementation and critique.

Goals, objectives and targets represent a hierarchy of concepts ranging from very abstract to the very precise and related to time spans varying from many decades to just one year or even less.

Goal - Goal is defined as an object or end that one strive to attain. Goals are abstract.

Objectives - are the ends towards which activities are aimed at. Objective serves as guides to immediate action. Objectives are more precise. It is one of the key step in planning and the desired results of development statements that represent specific steps on the way to attaining selected goals. Effective objectives provides yard sticks for measuring comparing and evaluation performances.

Effective planning is that planning which is most likely to work and is able to bring about the result intended. To write objective strong action verb such as conduct, build, construct, install, eradicate, reduce, increase or make should be used.

Project Out Line

While preparing research project following outline should be used - title, justification, review of literature, objective, procedure, duration of study and budgetary requirements.

Program - is a major inter-disciplinary area of research, training and extension. A program statement gives the needs and objectives of work and defines the major lines of work to be undertaken during specific period.

Rejection of Project Proposals

Project proposals are usually rejected due to weak methodology, irrelevance to present needs, and scientific merit of proposal and incompetence of the proponent to conduct the research project. The reason of rejection may be one reason or combination of reasons.

In a survey it was found that 73% of the project was rejected as methodology employed by the proponent would not give the designed result, 50% was rejected as importance of timeliness of the problem being studied was doughtful and 53% was rejected due to incompetence of the proponent. The proposals are also rejected due to irrelevance to the agricultural need of the country.

It is most important to remember that the ultimate goal of the agricultural research is the improvement of the quality of life of the rural people.

Sustainability Of Technology

Sustainability is the ability of a system to maintain productivity when subjected to stress or perturbation. Steady decrease yields of continuously cropped maize fields on steep slop which causes soil erosion indicates low sustainability. The properties of sustainability is also resistance and resilience.

Sustainability along with productivity, stability and equitability are properties of system. Lack of sustainability may be indicated by declining productivity. These may be expressed as kilogram in biological, Taka in economic and calories in nutritional factor.

Agronomic sustainability can be measured at the field level, micro-economic sustainability at the farm level, ecological sustainability at the watershed level and macro-economic sustainability can be at the national or regional level.

Technical Feasibility

Ability of a farmer to execute it with a specific resource structure such as labour, chemicals, credit, drought, power, equipment and produce markets.

Common Indicators

i) Yield or live weight performance.

ii) Adaptability of adverse condition.

iii) Sustainability to yield.

iv) Farmer's capability and resources.

v) Site specificity.

<u>Economic Viability</u>

Cost of resources and prices of the products produced by the technology.

i) Resource budgeting - peaks and tough of resources availability.

ii) Whole farm analysis - return to scarce farm resources like labour and capital.

iii) Partial budgeting - indicators are the additional returns and the marginal benefit - cost ratio.

iv) Enterprise analysis - indicators are cash and non-cash farm income.

v) Market analysis - market demand and supply of the product, market outlets and arrangements.

<u>Socio Cultural Acceptability - Indicators</u>

i) Adoption

ii) Change in attitude

iii) Decision making

iv) Cultural practices

v) Role of women

vi) Other descriptions

Improved systems should be evaluated by adoption indices by individual farming family's and other neighboring farm families potential. Suitable improved practices may be evaluated by three criteria. i) Technical element ii) Exogenous factor iii) Indigenous factor

Suitability can be assessed in an ex-post sense through various methods of acceptance such as adoption indices. The willingness to adopt a particular technology will be partially determined by ability to do so. The prices to the inputs and market for product produced will affect willingness to adopt are critical issue.

The condition for adoption may be dependent on following :

i) Technical feasibility

ii) Social acceptability

iii) Compatibility with extension institutions or support system.

The improved practices must be compatible with the goals of the potential adopter. Usually food self sufficiency is the first goal then profit maximization.

Profitability should be consider by both self consumption and its price during consumption and sale of the produce. If the desire is for food self sufficiency then avoiding risk by ensuring dependability of return from an innovative criterion. If the improve practices can be proved to be more profitable and as dependable as those they replace, they are likely to be attractive to farming families.

Present Status of Farming Systems Research

Component technology research in farmers' fields was initiated in the late 1950s in Bangladesh. Rice based and sugarcane based cropping systems research began in 1974. In 1979 the national coordinated cropping systems research programme was started with participation of nine organizations. Crops contributed 37% livestock 7%, fisheries 1%, and forestry3% of total Gross Domestic Product therefore in 1983 emphasis was given to a more comprehensive farming systems approach to include livestock, agroforestry and fisheries depending upon the priority given to the problems needing to be solved after exploratory and/or diagnostic survey. In all cases socio-economic studies were an essential part of the research plan.

A series of training courses on farming systems research methodology were organized since April 1982 and 176 NARS participants were trained.

More than 90 cropping patterns with associated available technologies were tested, adjusted and modified in 28 different agro-socio-economic environment in 15 districts (Appendix-1). Sixteen cropping patterns with associated technologies under rainfed condition and five cropping patterns under irrigated condition have been recommended for multilocation testing in different environments. These patterns have the potential to increase the yield from 11 to 194% and net income from 20 to 188% (Appendix-2).

Homestead vegetable production and utilization research was initiated in 1986 to improve the nutritional status and generate employment for women and children. Five vegetable cropping patterns were recommended and 2000 demonstrations were organised in 20 upazilas. The success was high so it will be extended to 200 upazilas. Women to women dissemination of technologies were initiated through family planning volunteers in 3 upazilas where 1500 volunteers will participate. Fisheries research systems have been included in eight potential sites out of 21 FSR sites (Appendix-1). Agroforestry and livestock research will be strengthened in existing sites. The matured technologies have been prioritised and it will be disseminated through block demonstration and pilot production program. The future thrust of FSR is to integrate all sub-systems with holistic approach.

Appendix-1

National Coordinated Farming Systems Research And Development Program 1990

Institution		FSR site	District
1. BARI (10)	1.	Kalikapur *	Pabna
	2.	Hathazari *	Chittagong
	3.	Narhatta	Bogra
	4.	Janokinathpur *	Rangpur
	5.	Saroil *	Rajshahi
	6.	Narikeli	Jamalpur
	7.	Palima *	Tangail
	8.	Bagherpara	Jessore
	9.	Lebukhali	Patuakhali
	10.	Kalapara +	Patuakhali
2. BRRI (1)	1.	Sreepur	Gazipur
3. BJRI (2)	1.	Kalampur	Dhaka
	2.	Kanaipur *	Faridpur
4. SRTI (3)	1.	Ishurdi	Pabna
	2.	Joypurhat	Joypurhat
	3.	Thakurgaon *	Thakurgaon
5. BLRI (2)	1.	Baghabari	Serajganj
	2.	Naikhong Chari +	Chittagong
6. BFRI (1)	1.	Bandarban	Chittagong
7. BAU (2)	1.	Kazirsimla *	Mymensingh
	2.	Noagaon	Kishorganj

*** Fisheries Sub-systems included in 1990**
+ New FSR site

Appendix-2 : Cropping patterns recommended as a result of testing at various CSR/FSR sites for multilocation tests in similar agro-ecological condition in Bangladesh.

Summer II (Aman)	Winter (Rabi)	Summer I (Aus)	Institutes	Increased percent Yield	Net return
		IRRIGATED			
Rice	Rice (Boro)		BRRI #	67	51
Rice/Mustard	Rice (Boro)		BRRI #	55	92
Rice	Wheat	Rice	BARI	85	135
Rice	Potato	Maize	BARI	160	188
Rice	Rice (Boro)	GM	BRRI #	45	119
		RAINFED			
Rice	Fallow	G. M.	BARI	32	89
Rice	Fallow	Rice	BARI*	46	84
Rice	Chickpea+Barley		BRRI	105	111
	Mustard	B.Rice	BARI	47	148
	Mustard+Lentil	B.Rice	BARI	61	21
	Mustard	Jute	BJRI	117	131
	Sugarcane+Potato		SRTI	23	20
	Sugarcane+Mustard		SRTI	11	27
	Lentil	Jute	BJRI	36	49
Rice	Wheat	Jute	BJRI	35	60
Rice	Wheat	Rice	BARI+	94	101
Rice	Chilli	Rice	BARI	31	38
	Potato	Jute	BJRI	16	34
	Wheat	Jute	BJRI	18	77
Dhaincha-Potato+Garlic+Pointed guard			BARI	194	57
Rice	Wheat	Mungbean	BARI	26	38

* BRRI, # BARI, + BAU, GM-Green Manure, B = Broadcast
(+, *, # & indicate more than one institutes findings)

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GUIDELINES FOR PLANNING TRIALS FOR FARMING SYSTEMS RESEARCH

Mrinal K. Chowdhury

Farming is an activity carried out by households on holdings that represent managerial units organized for the economic production of crops, livestock (Ruthenberg, 1990) and fishes. The owners of the households i.e. the farmers have at their disposal certain physical, biological and socioeconomic resources on the basis of which they arrange their farm production with the technology they have. The whole activities of the farm for the purpose of production and consumption result in a system. A system is a group of interacting components operating together for a common purpose and capable of interacting as a whole to external stimuli : it is unaffected directly by its own outputs and has a specified boundary based on the inclusion of all significant feedbacks (Spedding, 1988).

Concept of Farming Systems

Farming systems are defined by their physical, biological, and socioeconomic setting and by the farm families' goals and other attributes, access to resources, choices of productive activities (enterprises), and management practices.

Shaner et al. (1982) consider a farming system as a unique and reasonably stable arrangement of farming enterprises that the household manages according to well-defined practices in response to physical, biological and socioeconomic environments and in accordance with the household's goals, preferences, and resources. The farming system is part of larger systems - e.g. the local community. This can be divided into subsystems like cropping systems, animal production systems, fish production systems, agroforestry systems, etc.

According to CGIAR (1976) "a farming system (or farm system or whole farm system) is not simply a collection of crops and animals to which one can apply this input or that and expect immediate results. Rather, it is a complicated interwoven mesh of soils, plants, animals, implements, workers, other inputs and environmental influences with the strands held and manipulated by a person called the farmer who, given his preferences and aspirations, attempts to produce output from the inputs and the technology available to him. It is the farmer's unique understanding of his immediate environment, both natural and socioeconomic, that results in his farming systems".

Farming Systems Research

Farming systems research (FSR) is an approach to agricultural research and development that (1) views the whole farm as a system, and (2) focuses on the interdependencies between the components under the control of the farm household and (3) how those components interact with the physical, biological and socioeconomic factors not under the household's control.

Farming systems research addresses itself to each of the farm's enterprises, and to the interrelationships among these enterprises and between the farm and its environment. It employs information about the farm's various production and consumption systems and about farm environment (physical, institutional, social and economic) to increase the efficiency with which the farm utilizes its resources (Zandstra et al. 1981).

FSR has the following characteristics :

It views the farm as production unit and the rural household as consumption unit--which in the case of small farmers are often synonymous--in a comprehensive manner.

FSR recognizes the interdependencies and interrelationships between the natural and human environments. Priorities for research reflect the holistic perspective of the whole farm/rural household and the natural and human environments.

Research on a sub-system can be considered part of the FSR process if the linkages with other sub-systems are recognized and accounted for and farming systems research is evaluated in terms of individual sub-systems and the farming system as a whole.

FSR is a farmer-oriented, system-oriented, interdisciplinary, multidisciplinary, problem-solving and dynamic approach. It complements, not replaces, the mainstream commodity and disciplinary research.

The operational activities of FSR is conveniently grouped into four stages (Fig.1). These are :

i. Diagnostic or descriptive stage
ii. Design stage
iii. Testing stage
iv. Dissemination or extension stage

Planning for on-farm experiments is done mainly during the design stage.

FSR PLANNING

The FSR teams usually follow the activities listed below in establishing its research program. These are adapted from Shaner et at. (1982). Other approaches are possible, since planning is highly personalized and depends on local conditions. Moreover, as the team gains experience in an area, it may give some elements only cursory attention or even skip them.

The planning activities involve

1. Laying the groundwork for on-farm research
2. Making preliminary analyses of on-farm experiments
3. Considering alternative research activities and methods
4. Finalizing plans for on-farm experiments.

FSR teams facilitate this process by holding monthly District Technical Committee meetings and regional research-extension workshops prior to the season's activities.

```
                                   ------------> External    __
                                  |              institutions  |
1.  Diagnosis of     <------ Existing farming                  |
    present farming ------->      systems                      |
    systems                         |                          |
                                    |                          |
                                    v                          |
2.  Design of       <--------- On-station <------- Body of     |
    improved         --------->  trials    ------> knowledge   |
    systems                         |                 |        |
                                    |                 |        |
                                    v                 |        |
3.  Testing of      <----------- On-farm  <------     |        |
    improved         ----------->  trials  ------>    |        |
    systems                         |                 |        |
                                    |                 |        |
                                    |                 |        |
                                    v                 |        |
4.  Extension of                 Modified             |        |
    improved          <--------- farming  <-----------         |
    systems           --------->  systems  <-------------------
```

Fig. 1. Schematic framework for farming system research process (Adapted from Norman, 1982).

Laying the groundwork

In arriving at a suitable plan of on-farm research for a region, FSR teams need to undertake several activities. These include :

i. reviewing priority problems and opportunities
ii. appraising the organization's capabilities and resources
iii. appraising present technologies
iv. setting assumptions about near-term conditions
v. categorizing and setting research priorities
vi. developing hypotheses for testing
vii. establishing research collaboration.

Reviewing priority problems and opportunities

The team begins by carefully reviewing the priority problems and opportunities. This review produces a modified and smaller set of problems and opportunities from those selected during problem identification or the diagnostic stage.

In making this review, the team should seek help from appropriate specialists whenever it lacks the appropriate experience. However, by participating in target and research area selection and by its initial identification of farmers' problems and opportunities, the team should be reasonably prepared for this planning task. The team will have gained an understanding of the farmers' objectives, the prevalent farming systems in the area, the environmental characteristics, and any generally supported research strategy for the area's farmers.

Appraising the organizations capabilities and resources

FSR teams need to consider their capabilities and resources in relation to the tasks confronting them. Specifically, they need to consider the organization's strengths and weaknesses as related to the problems and opportunities to be investigated.

Appraising present technologies

In deciding among the alternative possibilities for research and development, the FSR team needs to know what technologies are available within the area. Present technologies serve as a good starting point for solving some of the more pressing problems and beginning on-farm experimentation. The team should be able to identify potentially relevant technologies by reviewing reports and data from local experiment stations and from regional, national, and even international research organizations. The team members might also talk with those knowledgeable about the area's research and farming practices. In this way, the team seeks to match technological possibilities with the identified problems and opportunities.

Setting assumptions about near-term conditions

To help in the selection and design of research activities, the FSR team needs to make reasoned assumptions about the environment over the next five or six years. If there are possibilities of introducing large Scale irrigation facilities in the area, the team should not take a big research programme on rainfed farming.

Categorizing and setting research priorities

The selected problems and opportunities can next be divided into whether the farmer does or does not have control over the factors necessary for making improvements. We generally consider that the farm household has reasonably complete control, within limitations set by society, over the family's resources and activities pertaining to the farmer's system. Similarly, we consider that the farm household has little effective control over the environment, except occasionally through organized groups of farmers acting on their own or by influencing the government.

Consequently, much of the FSR effort will be directed to changes in cropping and livestock patterns and farm management by means of on-farm experimentation. Nevertheless, the team should not overlook opportunities to conduct research on the farmer's environment (Particularly Socioeconomic environment) through special studies and by other means.

Developing hypotheses for testing

The team should be able to state the hypotheses for research on problems and opportunities. Combined, these hypotheses will establish the general direction and nature of the overall FSR effort. For example, a major objective might be to add a second or third crop to the farmer's existing cropping pattern.

Researchers should form these hypotheses in such a way that (1) the tests of the hypotheses will yield meaningful results for the overall approach and (2) the technologies will be within the farmers' and agencies' capacities to implement. For example, the hypothesis "an earlier planting date for the second crop will increase the farmers' overall output per unit of scarce land" would not be useful if the farmers cannot prepare the land in time. Only if there is a means for quicker land preparation, then the hypothesis about an earlier planting date could lead to useful experiments and conclusions.

Establishing research collaboration

By integrating the various hypotheses about priority problems and opportunities, the FSR team should be able to formulate a coordinated research program. The team will need assistance from qualified organizations and individuals in implementing this program. For example, help might be sought in clarifying an animal disease, learning how a water users' organization functions, trying to secure more favourable credit, or finding a solution to a soil salinity problem. These will need help from several disciplines.

Making preliminary analyses of on-farm experiments

Alternative solutions

Before deciding on a particular approach, the team should consider the alternatives. Failure to consider the better alternatives will produce inferior results no matter how well the experiment is designed. Searching for alternatives takes an open mind, imagination, and considerable judgment and experience. Categories of alternatives to consider include :

- increasing output from a given level of resources such as substituting a new technology for an old one - e.g., introduction of a new variety-or introducing better management practices
- e.g., planting densities or on-farm conservation of water and soil,
- increasing resources - e.g., more land, credit, and cooperative labour -coupled with increasing output enough to justify the increase in inputs,
- reducing farmers' risk through more reliable inputs, more uniform outputs, or more stable prices,
- reducing the inputs to produce a given output,
- increasing farmers' satisfaction in other ways than the above such as increasing family health through better nutrition or working conditions.

Farmers' conditions

The farmers' potential acceptance of technological change requires improvements over what the farmers' conditions would be were the changes not introduced. Because most farmers' conditions are stable, this means studying the farmers' current situations. Such study means understanding, as best possible, the farmers' environment, objectives, resources, enterprises, and management practices, and of course, the linkages among these elements.

In addition, some estimate is needed of the degree of improvement sufficient to interest farmers in change. When yield increases are the objective, some researchers use a 30% increase as the minimum amount farmers can easily discern and, therefore, are willing to accept. However, household that are better off and accustomed to change may accept values less than 30%. On the other hand, households operating near subsistence will be constrained by shortages of cash and credit and will generally be most concerned about producing a stable food supply and other family requisites. Households near subsistence levels may require both yield increases of more than 30% and assurance that the possibility of losses is not great.

Perspectives

The team must understand the farmer's perspective because farmers can accept or reject the proposed changes in their enterprises and management practices. In addition, the team should ascertain whether its proposed changes will be in society's immediate and future interests.

When dealing with these two perspectives, the team will usually find that considering the farmer's viewpoint calls for specific information about the technology and the farmer. Society's interests should also be taken into account. For example, the team might judge that the increased yield from using pesticides is large enough to interest certain farmers in the research area. In contrast, the team could encounter difficulty in judging the long-run effects on the environment from the widespread use of these pesticides. For the latter situation, the team might well seek expert advice.

Technically viable designs

In planning experiments, the FSR team should work toward technically viable designs rather than toward optimal designs. Optimality does not have much operational meaning within the complexity of farmers' circumstances. On the other hand, technically viable designs can be prepared to raise the farmers' benefits enough to gain their interest.

Physical conditions. Soil, topographic, water, and climatic conditions should be representative of conditions encountered by the groups of farmers for whom the technologies are being designed. If shallow, sandy soils prevail, then the team should select these types of soils for the on-farm experiments. If most of the farmers' land is on hillsides, that is where the team should place the experiments. If the farmers plant under rainfed conditions, the team should do likewise.

Biological conditions. The team needs to consider the farmers' existing cropping and livestock patterns as the starting point for introducing changes in patterns and in management practices. Then, the team should study the biological characteristics of alternatives to learn how they can be incorporated into the farmers' existing system. For example, the team might consider whether the farmers have enough time after harvesting their traditional crops to plant any new short duration crops.

Economic conditions. The team should be reasonably sure that future economic conditions will support the change in technology. For example, the technology's requirements for labour, supplies, and services need to be available, and the output should be acceptable for the family's use or be in demand by others.

Financial conditions. The team should compare the monetary requirements for any proposed changes against the farmers' financial resources. In checking on the financial needs of such purchases as supplies and equip ments, the team should consider the farmers' reaction to credit, dealing with lenders, and the time required for these transactions.

Sociocultural conditions. The team needs to be sensitive to the influence of the community and prevailing customs on farmers' decisions. At times, the social system will restrict the types of technologies that can be intro duced. For example, pig raising can be otherwise a profitable enterprise but would not be acceptable to majority of the farmers in Bangladesh.

Estimating values (Ex-ante analysis)

The team requires to estimate both quantities and prices for inputs and outputs. In making these estimates, the team should select val ues that are as representative as possible of the values they believe will prevail if the technologies are introduced.

After obtaining an unbiased estimate of a new technology's value, the team can apply analytical techniques designed specifically for taking uncertainty into account (e.g. sensitivity analysis). For this, the team needs to gather data on alternative quantities and prices over a range ofpossible outcomes. The team can then use these additional estimates to evaluate how a proposed technology looks under varying assumptions.

For subsistence farmers many inputs and outputs do not involve cash transactions. The team estimates the "opportunity cost" of the input and output and uses this as the market-based value. The opportunity cost is the value of an item in its best alternative use.

Eventual consequences

Finally, the FSR team should take the precaution of trying to anticipate the eventual consequences of the changes it proposes. The consequences apply to both farmers and the environment. While precision in predicting the full range of possible effects is unrealistic, the team should try to estimate how specific small farmer groups might be influenced. When the government is unable to protect the interests of the farmers for whom the research is intended, the team may want to work on other technologies that do not threaten farmers' welfare. For example, consider the introduction of a new variety that increases yields through the application of high rates of fertilizers. If small farmers frequently cannot obtain these fertilizers while the larger farmers consistently can, the net result could make the small farmers worse off. They would be worse off should their output remain the same and prices fall because of increased production of the crop (by the rich farmers) in the area.

Considering alternative research activities and methods

An important part of the planning process is to identify which activities to undertake and which methods to apply.

Research activities

Technology development. Research on technology development is under taken to (1) better understand the individual and combination of technical factors affecting plant or livestock production and (2) develop new and improved technologies. This research relates to cropping and livestock patterns, mixed crop and intercrop combinations, cropping pattern management - e.g., use of high yielding varieties, pest control, fertilizer response, and planting dates - and livestock management - e.g., animal nutrition, pest control, feeding trials, and use of crop residues as animal feed. Technology development may also apply to on-farm water and soil erosion control in rainfed areas and to various moisture conservation practices of irrigated areas.

Farmer adaptation. The FSR team uses its understanding of the farming system, background information on technology development, and farmers' suggestions to improve the farmers' systems. These improvements include such possibilities as introducing new or additional crops or animals into existing patterns, redesigning farmers' management of existing patterns, finding better methods for storing crops, and so forth. The approach to farmer adaptation of technology is for the researchers to learn how farmers react to introduced change - to what extent the introductions are accepted, modified, or rejected - and to learn why farmers act the way they do.

Management of the farming system. For a given farming system, the team may want to find out about the farmers' year-round use of farm labour, the periodic value of sales of crops and livestock, seasonal feed requirements of livestock, timing of field operations, periodic expenditures for crop and livestock production, harvesting and post harvesting losses, planting and harvesting dates, and areas devoted to specific crops. The teams collect such information by sampling and recording data across the area and, thereby, obtaining more complete and representative descriptions of farmers' management practices.

Management of natural resources. Activities concerning management of natural resources go beyond the single farm to the consideration of the farmers' general environment. For example, (1) improvements may be made to the area's irrigation system; or (2) research may be directed toward solving problems involving salt-affected soils.

Research methodologies

A variety of research methods have been taken from various origins and adapted to FSR's specific needs. Particularly useful are researcher-managed trials, farmer-managed trails, superimposed trials, surveys, record keeping, monitoring, and experiment station support.

Applying methods to activities

Especially in the early stages of FSR, the team will need to con sider (1) an effective division of effort among the various research activi ties, and (2) which research methods to apply. During problem identifica tion, the team will be analyzing the current level of technology in the area. If little technology is suitable for the selected group of farmers, the initial emphasis should be on technology development. But where a large body of technology is suitable for introduction at the farm level, more attention can be given early to farmer adaptation research. In this case, farmer-managed trial is the principal method.

Finalizing plans for on-farm experiments

Deciding on the design conditions

Four conditions can be used as the basis for designing and con ducting experiments with alternative cropping patterns. These are :

- farmers' present cropping patterns and management practices to provide baseline information for comparison with other pat terns and practices,

- farmers' present cropping patterns with input and market con straints removed - to evaluate how farmers would alter their management practices were input and market conditions more favourable.

- new cropping patterns with low levels of inputs - when trying to influence farmers to accept new patterns.

- new cropping patterns without input and market constraints and with new technical assistance provided - to estimate the potential for improving farmers' production.

In addition to these four conditions, the FSR team should consider a fifth possibility. This would be the condition whereby farmers' resources and cropping patterns remain unchanged, but management is improved.

Searching for improvements

The team might emphasize one or more of the following :

- comparisons with farmers within the research area
- comparisons outside the research area
- farmers' uses of resources
- productivity criteria.

Setting design standards

These are general standards that guide the team in (1) setting up the experiments so that useful results will be obtained, (2) avoiding unnecessary detail and complexity, and (3) gaining uniformity among experiments across areas and over time. This third factor allows for differences in experimental conditions due to climate, economic factors, and other uncontrollable variables, as well as for identifying trends over time.

The important issues for consideration are (1) types of farmers, (2) locations of experiments, (3) number of experiments, (4) design complexity, (5) experimental design characteristics, (6) methods of analyzing research results, and (7) methods for handling incomplete experiments.

<u>Types of farmers</u>. The team will need to decide something about the characteristics of the farmers to be chosen as cooperators in the experiments. Even for farmers described as being relatively homogeneous in terms of their resources, cropping and livestock patterns, and management practices, the FSR team will find differences in attitudes and the willingness to cooperate. The team must decide whether to select those farmers who show the greatest willingness to cooperate or to select farmers who are more representative of the area's average farmers.

Locations of experiments. Once the farmers have been selected, the team will need to decide how to choose among alternative fields and locations within the fields. Replicated experiments conducted within the same farmer's field give the greatest uniformity of conditions for the exper iments; and additional experiments across the research area give greater understanding of the area.

Number of experiments. Important to the complexity and thoroughness of the research program will be the number of experiments the team attempts during the year. This decision depends partly on the team size, members' experience, the nature of the research program, available resources and the size of the area.

Design complexity. The team's effectiveness can be enhanced if its members can adequately judge the appropriate level of experimental com plexity - both for the team and for the farmers. While researcher-managed trials can be complex and involve a large number of treatments, FSR practitioners generally agree that the number of treatments should be kept small. This slower, step-by-step approach to research (1) fits in with the more difficult conditions under which on-farm research is conducted, (2) adapts better to the lesser experience of the field team when compared with experiment station staff, and (3) reflects the need to introduce technical change relatively slowly through farmer-managed tests.

Experimental design characteristics. Plot size, number of treatments and replications, and field design are responsive to the methods and objectives of each experiment. For on-farm trials with large animals, a minimum of 20 to 30 animals is recommended. For cropping pattern tests, probably 40 to 50 test fields are required. In practice, however, fewer animals/fields are used due to resource limitations.

Methods of analyzing research results. During this planning stage the team needs to agree on how it will analyze the research results. This will influence the types of data to be collected, the way the experiments are conducted, and how decisions about the technologies are reached. Following are some questions that the team may want to consider :

- which statistical procedures should be used in analyzing the results of the biological experiments ?

- will whole farm analysis be attempted, or will partial budget analysis be used ?

- what minimum yield increases and change in risk are acceptable to farmers ?

- what type and rate of profitability will be considered acceptable to both farmers and society ?

- what coefficients of variation (C V) will be considered satisfactory for the different types of experiments ?

<u>Methods for handling incomplete experiments</u>. Experiments can be voided for a number of reasons, including natural phenomena, farmers' actions or inaction, or social unrest. Some examples include insect infestations, flooding, droughts, farmers' harvesting of the plot before yields have been measured, livestock's destruction of crops, and labour shortages during critical periods. Regardless of the reason for the disruption, the FSR team should plan on appropriate action for handling these instances. As a minimum, researchers whose experiments were voided should record the circumstances and explain the reasons for the voidance. The team should keep these reports as part of the research results.

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THE EX-ANTE ANALYSIS OF RESEARCH DESIGN

Dr. S. M. Elias

The need for assessing the appropriateness of new technologies both on the farm and in a wider social context is now accepted widely by the technology generating research institute. The assessment of technologies can take place at different stages in their process of generation.

Most assessment studies of new technologies have tended to be 'ex-post' evaluation, when the levels of adoption of technology and their consequences are analyzed, and its relative benefit-cost evaluated. The findings of such studies have undoubtedly influenced the nature and direction of subsequent research. However, where inappropriate technologies have been developed and then actively pushed through large-scale programmes, the social and economic costs have been considerable.

On the other hand, 'ex-ante' assessment of technologies can help the researchers and policy makers to avoid such costly mistakes. It may also provide useful information for the design of more appropriate system.

Performance criteria

In the design of any experiments, three levels of suitability are considered-biologically feasible, technically feasible and economically viable alternatives.

For biological feasibility, the environmental factors are physical, climatological and biotic, such as amount and distribution of rainfall and irrigation, landscape hydrology, drought, saturated soil, high precipitation, and humidity during the crop establishment and harvest periods, temperature and day length variation, extreme soil condition, predictable flooding and hard-to-control pests. A biologically feasible technology will grow in these conditions well enough to achieve locally acceptable yield levels.

Technical feasibility of new technology is determined by the ability of a farmer to execute it with a specified resource structure. It is thus decided by the availability of such resources as labour, chemicals, credit, draught power, equipment, produce market etc.

The economic viability of the new technology is determined by the costs of these resources and the prices of the products produced by the technology.

How to Match to the criteria ?

Biological feasibility

Research design for biological feasibility is a process of matching the physical requirements of the crop to physical conditions of land type and environment.

- Ø First, develop tables for the crop requirements for soil, water, temperature, day length and solar radiation.
- Ø Second, prepare tables for crop damage conditions such as flooding depth, excessive evaporative demands and excessive wind.
- Ø Third, express the condition of the land type in tables or graphic form for water in and on the soil, temperature, daylenght and solar radiation. For crop damage variables, graphs of probability of occurrence are appropriate.

These tables can be matched with the yearly graphs each environmental factor at periods considered for the production of the crop.

Technical feasibility

Other important factors for research design are the choice of management technology and input levels. They depend on the limits to the type of and expenditure for equipment, chemical and labour inputs and managerial skills. These information can be available from the survey or from other studies.

- Ø Prepare a list of crop management resources.
- Ø List the present practice and use of resources per unit area.
- Ø Set the present limits, assuming no additional support.
- Ø Set projected limits conservatively considering additional support for the new technology.
- Ø Evaluate the technical feasibility of the new technology by comparing its estimated resource demands with the resources available.

If the demand for certain resources are excessive at certain time, the technology may be feasible only if it can draw on resources from other enterprise or from outside the farming community.

Eeconomic viability

The economic viability of a new technology can be determined by a budget analysis at the time of research design. This analysis uses costs of the variable inputs for all operations specified as well as a conservative estimate of expected yield. Initially costs are estimated from the survey data. The profitability and returns to resources of the new technology can be compared with those of the existing technology.

The following techniques are usually used to assess economic viability of a new technology.

1. Marginal analysis

It calculates the additional benefit which would be derived to additional one unit of cost of new technology.

2. Partial budgeting

Return above variable cost of new technology can be compared with the same of the present technology used by the farmers. Estimates of expected yield from a stated level of material inputs to be used, estimates of the new technology and the relevant price and wage data will be required. On the other hand, yield, material inputs level, power and labour usage, prices and wage information concerning to the farmer present practices should also be available for comparisons.

3. Break-even budgeting

It estimates the yield required to cover the variable costs and in addition certain percentage grace for risk coverage over farmers practices. The effect of price and its relation to the final break-even yield of the crop would also be variable. For a new technology to have likely adoption, it must have break-even yield and prices that reflect the lower limit of net benefit that a farmer is willing to accept.

Parametric budgeting or sensitivity analysis

Parametric budget or sensitivity analysis are used to determine the levels of yields and/or prices that the recommended technology have to provide in order to make them acceptable to farmers.

The technique tests systematically what happens to the net benefits or profitability of the farm if prices, yields and other events differ from the estimates made about them. Sensitivity analysis is a means of dealing with uncertainty about future events and values. The analysis is done by varying one element or a combination of elements and determining the effect of that change on the net benefit of the new technology.

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USE OF STATISTICAL PROCEDURE FOR DESIGNING FARMING SYSTEM RESEARCH

Kamal Rahim

The farming systems research (FSR) views the whole farm as a system and focus on the interdependencies among different components which are under the control of members of farm household and how these components reacts with the physical, biological and socio-economic factors not under the household's control. The approach involves :

1. Selection of target area.

2. Selection of farms and conduct farm survey.

3. Identification of problems to be solved.

4. Designing and executing on-farm research.

5. Evaluation and implementation of on-farm research.

The FSR thus involves a series of steps starting from the selection of target area to the implementation of results where the farmers are directly involved in all stages of research. Most of the steps demand sound statistical procedures for valid and reliable inference. Statistical principles can be effectively used in -

a) identification of problem and designing of new technology through farm survey,

b) developing and testing of new technology through on-farm testing, and

c) evaluation of new technology through follow-up survey.

FARM SURVEY

Farm survey is an essential process in farming system research for following reasons :

1. Many socio-economic factors that cannot be measured in a field experiment are easily measured through a farm survey.

2. The cost is less compared to a field experimentation thus gives a wider coverage with less cost.

3. Farm survey can gather information about the past activities that may be useful as the basis for designing the new package of technology for verification.

Two types of farm survey are required

1. Pre-design or base-line survey which is conducted before the establishment of on-farm experiments.

2. Follow-up survey is designed to determine the potential constraints to farmer's adoption of new technology and institutions required to accelerate farmer's adoption of new and more productive technology.

We are not going to discuss different sampling techniques since they are covered by a separate lecture.

Designing of the New Technology

A major task in technology verification process is to test designs of production technologies expected to be superior to farmer's existing practices. The pre-design survey contributes to the design phase by describing the farmer's existing practice and identifying which component of this practice are likely to constrain farm productivity. Improved practices are then substituted for these identified production constraints resulting in a newly designed package of technology that combines the desirable features of both the existing practices and the promising technologies derived from experiments.

ON-FARM EXPERIMENTS

The on-farm experiments for FSR can be classified as -

1. Technology generation experiments which are designed to develop new technologies, and

2. Technology verification experiments which are designed to compare the superiority of new technologies identified as promising by technology generation experiments over that of farmer's existing practices.

The statistical procedures for farms experiments will be discussed in relation to cropping systems only. The principles of statistical design and analysis are more or less similar for technology generation and technology verification. The researcher should have clear understanding of basic concept of experimental design which are discussed briefly.

PRINCIPLES OF EXPERIMENTAL DESIGN

Hypothesis

A hypothesis is a trial idea concerning the nature and connection of the observations. In other words, a hypothesis is a tentative idea as to how the facts are to be interpreted and explained.

Experiment

An experiment, either in the field or laboratory, may be defined as a planned inquiry of new fact(s) to deny or to accept the facts established earlier by previous workers, or to unearth natural phenomenon which still remains undiscovered. Thus, an experiment needs systematic and careful investigation. In other words, an experiment is designed to test the validity of the proposed hypothesis. The experiment is a critical step in the scientific method, and the question it seeks to answer should be crucial to the support or rejection of a hypothesis.

There is no clear-cut distinction between an experiment and a simple observation, but ordinarily in an experiment the observer interferes to some extent with nature and creates conditions favourable to his purpose.

Experimental Design

Designing an experiment simply means planning an experiment so that information will be collected which is relevant to the problem under investigation. Thus the design of an experiment is the complete sequence of steps taken ahead of time to ensure that the appropriate data would be obtained in a way which permits an objective analysis leading to valid inferences with respect to stated problem.

Initial Steps of an Experiment

Before planning actual experiments, the researcher should obviously have a good basic understanding of the nature of the problem and the relevant theory associated with it. It is almost essential that an experiment be designed on the basis of one or more preliminary hypothesis. These can be constructed more intelligently if a full knowledge of the theory and background of the situation is available.

It is rather poor policy to carry out an experiment without a clear-cut idea in advance of just what is being tested. Poorly exploratory experiments are necessary in a new field, and such preliminary searches are of great importance. Very often, however, a certain objective is the reason for undertaking a research, and yet when the experiments are over, it becomes apparent that the questions asked were not the ones whose answers were really needed. It is safest here to go right back to the origin of the equiry and ask at every stage : Why am I doing this particular thing ? Will it really tell me what I want to know ?

The first step in problem solving is to state the problem clearly and concisely. If the problem cannot be defined, there is little change of it ever being solved. Once the problem is understood, the researcher should be able to formulate questions, which when answered, will lead to solution.

Once the problem is identified, the researcher may state his objective which may be in the form of questions to be answered, hypothesis to be tested, or the effects to be estimated. Objectives should be written out in precise forms. When this is done the experimenter is in a position to plan his experimental procedure more effectively. Where there are more than one objective, they are to be listed in order of importance, as this might have a bearing on the experimental design. The objectives of the experiment must lead to the solution of the problem. The selection of a procedure for research depends to a large extent on the experimental material in which the research is being conducted, and on the objectives of the research.

Before starting an experiment, the following questions are generally involved which when answered help the researcher to conduct his experiment in a meaningful way :

1. What factors of treatments should be included in the experiment ?

2. What is the effect to be measured ?

3. What will be the experimental units in the experiment ?

4. How large an effect will be considered important ?

5. How many units will be used in the experiment ?

6. How does one assign the treatments under consideration to the experimental units ?

7. What should be the form of analysis ?

Experimental Error and Basic Principles of Experimental Design

The yield of a certain crop from two experimental units or plots treated alike would seldom be equal. Differences of this sort is beyond the control of the researcher. These differences among the experimental units represent the variability among the experimental units and are called experimental errors. This error is not the error of experimentation, this is inherent with experimental material which cannot be eliminated, but can be reduced by efficient use of experimental material.

Valid extimation of experimental error is an essential part in experimental design. The three basic principles of experimental design and replication, randomization, and local control. Because of the fundamental nature of these concepts, they are discussed separately.

A. Replication

By replication we mean the repetition of the basic experiment. The number of units assigned to a treatment is said to be its degree of replication. If the basic experiment, which consists of one plot for each treatment, is repeated 'r' times, we say, we have r replicates. Replication serves dual purposes. First, it makes a test of significance possible by providing an estimate of the experimental error. Second, replication makes the statistical test more sensitive as increased replication lands to reduction in the standard error of a treatment mean.

B. Randomization

Randomization enters into the validity of an experiment in several ways. The units used in the experiment should be random selection of the group to which the results will apply. Again the units allotted to each treatment must be a random selection of those used in the experiment as a whole. This is how we can ensure that no treatment is unduly favoured or handicapped in the experiment. Consequently, the treatment effects are free from bias. It is often desirable, however, to impose suitable restrictions on the randomizations in order to increase the precision of the experiment.

In tests of significance we usually assume that the observations are independently distributed. Randomization makes the test valid by making it appropriate to analyze the data as though the assumption of independent error is true.

Systematic designs, where the treatments are applied to the experimental units in a nonrandom but selected fashion, often results in either under estimation or over estimation of experimental error. Numerous studies have shown that adjacent plots tends to be more alike in their productivity than plots which are more distance apart. Such plots are said to give correlated error components or residuals. As a result of this fact, if the treatments are arranged in the same systematic order in each replicate, then there can be considerable difference in precision of comparisons involving different treatments. The precision of comparisons among treatments which are physically close is greater than those among treatments which are some distance apart. Randomization tends to destroy the correlation among errors and make valid the usual tests of significance.

C. Local Control

Local control allows for certain restrictions on the randomization in order to reduce experimental error and thereby improves efficiency of the experiment. Thus it refers to the amount of balancing, blocking and grouping of the experimental units that is employed in the adopted statistical design.

The purposes of local control is to make the experimental design more efficient. It makes the test more sensitive or powerful by reducing the experimental error.

Three Basic Experimental Designs

A. Completely Randomized Design

The simplest of all designs having a random arrangement is the completely randomized design. The design may be defined as one in which the treatments are randomly arranged over the whole of the experimental material. No effort is made to confine treatments to any portion of the entire area, material, or space. The number of replications for any one treatment may vary. The completely randomized design is usually selected when the experimental material is relatively homogeneous.

Advantages and Disadvantages

The chief advantages of the completely randomized design are :

i) It is easy to layout the design.

ii) The design allows for the maximum number of degrees of freedom for the error sum of squares.

iii) A completely randomized design has the simplest analysis of all experimental design subject for statistical analysis of data.

iv) Under number of repetition for the various treatments may be included without unduly complicating the analysis in most cases.

The chief disadvantage of the design is that it is usually suited only for small number of treatments and for homogeneous experimental material. When large number of treatments are included, a relatively large amount of experimental material must be used. This generally increases the variation among treatment responses. If this variation over the whole of the experimental material is relatively large, it is possible to select more efficient designs than the completely randomized one. This results in more precise estimates of the treatment means for the same field experiment because experience has shown other designs to be more suitable.

B. Randomized Complete Block Design

In the randomized complete block design the treatments are randomly allotted within each stratum. That is, the randomization is restricted within a block. Also, the variation among strata (replicates or blocks) is removed from the variation among replicates within treatments. Therefore, if it is desired to control one source of variation by stratification, the experimenter should select the randomized complete block rather than the completely randomized design.

Advantages and Disadvantages

The chief advantages of the randomized complete block design are :

i) **Accuracy** : This design has been shown to be more accurate than the completely randomized design for most types of experimental work. The elimination of the block sum of squares from the error sum of squares usually results in a decrease in the error mean square.

ii) **Flexibility** : No restriction is placed on the number of treatments or on the number of replicates in the experiment. In general at least two replicates are required to obtain tests of significance. In addition, check or control treatments may be included more than once with little complication to the analysis.

iii) **Ease of analysis** : The statistical analysis is simple and rapid. More over the error for any treatment comparison may be isolated and any number of treatments may be omitted from the analysis without complicating it. These facilities may be useful when certain treatment differences turnout to be very large, when some treatments produce failures, or when the experimental errors for various comparisons are heterogeneous.

The chief disadvantage of the randomized complete block design is that it is not suitable for large number of treatments or for cases in which the experimental block contains considerable variability.

C. Latin Square Design

In a randomized complete block design the restriction is imposed such that all treatments must appear together in a block in equal or proportional number of times rather than being allotted at random over the whole experimental area, as in the completely randomized design. For the latin square design, two restrictions are imposed - the experimental area is divided into rows and columns. Thus for latin squares, the treatments are grouped into replicates in two ways : once in rows and once in

columns. Through the elimination of row and column effects from the within treatment variation the residual or error variance may be considerably reduced.

Advantaged and disadvantages

The advantages of the latin square design over other designs are :

i) With a two way stratification or grouping, the latin square controls more of the variation than the completely randomized design or the randomized complete block design. The two-way elimination of variation often results in a smaller error mean square.

ii) The analysis is simple -- it is only slightly more complicated than that of the randomized complete block design.

iii) The analysis remains relatively simple even with missing data. Analytical procedure are available for omitting one or more treatments, rows or columns.

The disadvantages of the latin square design are :

i) The number of treatments is limited to the number of rows and columns. For more than ten treatments, the latin square design is seldom used.

ii) For fewer than five treatments the allocation of degrees of freedom for controlling heterogeneity is disproportionately large. Even with the replication of squares a disproportionate number of degrees of freedom is associated with rows and columns for two, three, and four treatments. When corrections are made for degrees of freedom the latin square may not be as efficient as the randomized complete block or completely randomized designs for two, three and four treatments.

Data Collection

Data in the field book is primarily arranged for ease of measurement in the field. At times, this may not be the form convenient for statistical analysis. Thus transcribing of data from the field book to the form required for data analysis may be necessary. There is every chance of committing mistakes is copying data. It is strongly advised that the field book should be designed so that statistical analysis can be done directly from it. If it is not possible, a plan should be developed so that only one data transcription is needed for all analysis.

A large number of data are generally collected from a single experiment irrespective of whether they are relevant or not. The collected data should properly evaluate the treatment effects in line with the objective of the experiment. Minimum number of items which are essential in providing essential information should be recorded. To be sure that no item is missing from data collection, the researcher should prepare the outline of possible summary tables and graphs that would help him to fulfill the objective of the experiment. The researcher should always prepare a schedule of data collection before the start of the experiment. This would ensure him to collect all relevant data from the experiment.

The number of observations or measurements necessary to make for a valid representative sample is an important but difficult question. Too few observations may not give accurate results. Too many would generate unnecessarily large, expensive and time consuming observations. Within limits, the researcher should select the size of sample which he can collect accurately and reliably.

The data should be checked immediately after collection for any mistake in recording. The suspicious data should be repeatedly rechecked immediately after collection rather than doing post mortem examination. If no defect in the collection of data is detected, the data of the particular plot should be discarded and considered as missing plot. If majority of plots of a replication provides suspicious data, the entire replication should be dropped from consideration.

EXPERIMENT FOR TECHNOLOGY GENERATION

The farmer's environment provides a wide range of biological and physical conditions and hence much care has to be taken in conducting experiments for technology generation in farmer's field or environment.

The test site for a technology generation experiment is selected to represent a site of physical and biological conditions, under which the experiment is to be conducted or for which the technology has to be developed. The method of site selection is generally purposive rather than random.

Because of lack of experimental facilities, large variation between farms and between fields in a farm, and problems of supervision by researcher due to poor accessibility, and size of experiment in farmer's field must be made as small as possible. This can be done by keeping the number of treatments and number of replications at the minimum. The on-farm experiments are generally factorial in nature. The number of treatments can be reduced by using fractional factorial treatments.

Regarding the layout of the plots, plot shape may be adjusted to suit the irregular shape of the field and the manner in which the leveling of the land has been done. If one field is not enough to accommodate the whole experiment, each field must accommodate at least one replication.

TECHNOLOGY VERIFICATION EXPERIMENTS

The primary objective of a technology verification experiment is to compare the performance of farmer's technology and the new technology at farmer's condition. The technology verification experiment uses :

a) farmer's field as the test site,

b) farmer's practice as the basis of comparison, and

c) farmer's practice as the level of management for growing the crop.

The test farm for technology verification experiment should be representative of the target area. This needs to identify the specific boundaries of the target area and choose the appropriate sampling technique for selecting test farmers.

In technology verifications experiment there are essentially two levels of each test factor, one at farmer's level and the other at the level recommended by the new technology.

In a technology verification trial the farmer's practice, obtained before the trial, may be modified by the farmer in the course of experimentation. Consequently, the farmer's practice used in the trial differs from that for the rest of the farm. In order to evaluate how accurately the farmer's practices has been simulated in the trial, "comparable paddy" technique is used. Experimental designs are available in which farmers establish their own level in the trial.

The Follow-Up Survey

The follow-up survey is conducted either towards the end or after completion of the verification trials when the specific components of the new technology that are more productive than farmer's practices have already been identified.

The sample farmers to be included in the follow-up survey consists of those participated in the field experiment and those who are familiar with the new technology. Those who did not participate should be selected from those used in pre-design survey.

The questionnaire for the follow-up survey concentrates on two types of information : first, the requirements of the new technology that can be satisfied or that are available on the farm; and secondly, the institutions that can provide the requirements that are not available on the farm.

The follow-up survey is designed primarily to identify the important constraints to the adoption by farmers of production technologies for which productivity has been shown by field experiments to be superior to that used at present by farmers. Consequently, the emphasis in analysis of data in the follow-up survey is to match the requirement of the new technology with the existing farm resources, to identify specific constraints to its adoption. A common procedure for data analysis and data summarization is to identify the probable constraints to adoption for each component technology and then to determine the frequency of farmers that are subjected to each of these constraints.

INTERCROPPING EXPERIMENTS

Intercropping is the growing of two or more crops simultaneously on the same field such that the period of overlap is long enough to include the vegetative stage. The crops are not necessarily sown at exactly the same time and their harvest time may be quite different. Two types of intercropping are :

Mixed intercropping (also called mixed cropping) : Refers to any cropping arrangement where there is irregular broadcasting or mixing of crops within the rows.

Row intercropping : Refers to an intercropping system where at least one crop is planted in rows.

In an intercropping system component crop is used to refer to individual crops making up the intercropping while sole crop refers to a component crop being grown alone, generally at optimum population and spacing. Intercropping yield rate refers to the yield of a component crop when grown in intercropping and expressed over the total intercropped area.

Experimental Design

The experimental designs and procedures for data analysis for monocrop experiments are well established. However, very little statistical work on intercropping has been done so far. Very little literature on intercropping includes description of the specific experimental design used nor the specific statistical analysis performed.

Good experimental design is at least as important in intercropping experiments as in monocropping experiments. The choice and structure of experimental plots are extremely important, and a proper allocation of treatments to experimental units is also required at the same time.

Intercropping tends to need rather larger plots of both crops and because of the need for large guard areas. If the guard areas are a very substantial proportion of the experimental area, as may easily happen in spacing experiments involved, then a systematic arrangement of treatments may be appropriate.

Because the experimental plots for intercropping experiments are often large there is a danger of allowing blocks of plots, for RCB, to become large also. Blocks should be restricted to eight or fewer plots; confounded designs or more general incomplete block designs should be encouraged.

Conducting experiments to investigate spatial arrangement effects in intercropping is complex due to the presence of two or more crops, each having different optimum spacing. For example, in an intercropping experiment involving two crops, it is necessary to consider the plant density of the two crops, the spatial arrangement in terms of within and between row distances for the two crops and the inter-relationship of the two spatial arrangements. But generally no intercropping experiment involves more than two of these five items.

Randomization may have some disadvantage in spacing experiments. First if spacing is being maintained in a square pattern, the experimenter would have to chose either of the following alternatives : a) keep a constant member of plants per plot, in which case the plots are all of different sizes which would be awkward to fit together in a block, and b) keep all plots at the same size, in which case a close spacing may have an unnecessarily large number of plants in a plot. Second, adjacent plots in a randomized design may have widely different plant density combinations, thus necessiting the use of large number of guard rows or border rows, around the plots.

To overcome the difficulties mentioned above systematic designs, introduced by Nelder and Bleasdale, are used. The main advantage of these designs is that the for guard rows between plots is eliminated, and as a result a large range of spacing treatment can be examined on a relatively small area. Thus, these designs can be very useful in gaining preliminary information on basic relationships between the crop yield and the plant densities of the crops.

Willey and Osiru introduced the concept of replacement series treatments in intercropping experiments. The replacement series treatments consists of the sole crop of each crop and some intercrop treatments formed by replacing a given proportion of each crop with the equivalent proportion of other crop.

Willey and Rao described an intercropping experiment using a parallel row systematic design. In this design the factorial structure of the treatments can be arranged in a conventional randomized design.

Note that when treatments are arranged systematically, the analysis of variance is not the appropriate initial form of analysis; rather an analysis of the responses to spacing should be based on fitting response models for each systematic set of plots, and then analyzing the set of fitted response models.

The use of factorial treatment structure with many factors in each experiment is essential if intercropping research program are to be efficient. Compared with monocropping research program, there are more factors to be considered in intercropping research because of the two crops. The main argument against the use of more treatment factors in intercropping research arises because most intercropping experiment is in the tropics where the experimental material is more heterogeneous than in the well established research institutes. If very small blocks are used because of the heterogeneity then some of the advantages of factorial structure is lost.

Many recent experiments on intercropping use split-plot design, not generally for any strong practical reasons of treatment application but for simplicity of plot allocation of treatments. The split-plot design involves different comparisons having different precisions in a much more complex pattern. The construction of designs using small blocks, from which all the main effects and the two-factor interactions of interest can be estimated, is extremely simple and should be utilized in intercropping trials.

Analysis

An intercropping experiment generally consists of (a) intercropping plots with different combinations of the component crops, and (b) sole-crop plots of each component crop. To analyze the data from an intercropping experiment, it is recognized that there is no single appropriate form for analyzing together the data coming from all plots of a given trial. It is extremely important to consider and use different forms of data analysis. Although crop yield in the most acceptable measure of productivity in monocropping, it is not as meaningful in intercropping where there is more than one product and the products are generally heterogeneous with respect to nutritional and economic value. There are two different ways of analyzing the intercropping data :

a) To analyze the yield of each component crop separately.
b) To analyze the yield of all component crops together which can be done in two different ways : (i) apply multivariats analysis of variance technique and (ii) aggregate the yields of different component crops into a single productivity index.

DESIGN, TESTING, MONITORING AND EVALUATION OF FSR WITH SPECIAL EMPHASIS ON CSR

R. N. Mallick

Research Design

A research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure. It must contain.

i) A clear statement of the research problem.

ii) Procedures and techniques to be used for gathering information.

iii) The population to be studied.

iv) Methods to be used in processing and analysing data.

The design includes an outline of what the researcher will do from writing the hypothesis and its implications to the final analysis of data. The design decisions should be in respect of -

i) What is the study about ?

ii) Why is the study being made ?

iii) Where will the study be carried out ?

iv) What type of data is required ?

v) Where can the required data be found ?

vi) What period of time will the study include ?

vii) What will be the sample design ?

viii) What techniques of data collection will be used?

ix) How will the data be analysis ?

x) In what style will the report be prepared ?

Research design may be split to following

i) Sampling design

ii) Observational design

iii) Statistical design

iv) Operational design

NEED FOR RESEARCH DESIGN

It facilitates the smooth sailing of various research operation which makes research as efficient as possible yielding maximum information with minimal expenditure of effort, time and money.

Important concepts relating to research design

i) Dependent and independent variables

ii) Extraneous variable

iii) Control

iv) Research hypothesis - is a predictive statement that relates an independent variable to a dependent variable.

v) Experimental and non - experimental hypothesis testing research - research in which an independent variable is not manipulated is called non Ø experimental hypothesis testing research.

vi) Experimental and control groups

vii) Treatments

viii) Experiment

ix) Experimental unit.

RESEARCH METHODOLOGY

Research Definition

1. "Systematised effort to gain new knowledge".

2. A carefull investigation or inquiry specially through scarce for new facts in any branch of knowledge.

3. A movement from the known to the unknown. Objective of research is to discover answer to questions through the application of scientific procedures.

Motivation in Research

Ø Degree, to solve problems, to face challenge, intellectual joy, service to society and respectability.

Types of Research

1) Descriptive - surveys and fact findings of different kinds e.g. Ex-post factor researcher has no control over variables research.

2) Analytical research - to make critical evaluation of the material.

3) Fundamental or basic or pure research gathering knowledge.

4) Applied research - finding solution of immediate problem.

5) Quantitative research - measurement of amount.

6) Qualitative research - involving quality or kind to know motive or desire - used in behabioral sciences. Used by experimental psychologist.

7) Conceptual research - related to abstract idea or theory used by philosopher.

8) Empirical research - relies on experience or observation. The researcher must first provide working hypothesis or guess as to the to the probable results and then get enough facts to prove or disprove his hypothesis.

Research promotes the development of logical habits of thinking and organization. Research provides the basis for policies. Research facilitates the decision of policy maker.

Research techniques refers - to the behavior and instruments used in performing research operations such as making observations, recording data, techniques of processing data.

Research methods - refers to the behavior and instruments used in selecting and consulting research technique. It is the methods that generate techniques.

Research methods refers to the methods the researches use in performing research operations. Research methodology - is a way to systematically solve the research problem. How the research is done scientifically.

RESEARCH PROCESS

Research process consists of service of actions or steps necessary to effectively carry out research and the desired sequencing of these steps. These are :

a) Formulating the research problems

b) Extensive literature survey

c) Developing the hypothesis

d) Preparing the research design

e) Determining sample design

f) Collecting the data

g) Execution of the project

h) Analysis of data

i) Hypothesis testing

j) Generalization and interpretation

k) Write up of conclusions.

<u>Qualities of good research</u>

1) Good research in systematic - set of rules

ii) Good research is logical

Induction - is the process of reasoning from a part to the whole.

Deduction - is the process of reasoning from some premise to a conclusion.

iii) Good research is empirical

iv) Good research is replicable.

<u>Identification of problem</u>

What is a research problem - problem refers to some difficulty experienced in situation and want to obtain a solution for the same.

Ø There must be an individual

Ø There must be some objective

Ø There must be alternative means

Technique involved in defining a problem

Ø Statement of the problem in a general way

Ø Understanding the nature of the problem

Ø Surveying the available literature

Ø Developing the ideas through discussions

Ø Rephrasing the research problem in to a working proposition.

Research design

A research design is the arrangement of conditions for collection that aims to combine relevance to the research purpose with economy in procedure.

Ø The sampling design

Ø The observational design

Ø The statistical design

Ø The operational design

Research design must contain

Ø A clear statement of the research problem

Ø Procedures and techniques to be used for gathering information.

Ø The population to be studied

Ø Methods to be used in processing and analysis data.

Research design in needed to facilitate the operations for maximum information with animal expenditure time and effort.

Hypothesis - Assumption or some supposition to be proved or disproved. Research hypothesis is a predictive statement, capable of being tested by scientific methods, that relates on independent variable to some dependent variable. Hypothesis is a proposition which can be put to a test to determine its validity.

Characteristics of hypothesis

1) Clear and precise

2) Capable of being tested

3) State relationship between variables

4) Specific

5) Simple

6) Consistent

7) Amenable to testing within a reasonable time.

8) Have empirical reference.

NULL HYPOTHESIS

What it is, and why we use it ?

Before a trial, the best guess is a hypothesis. The team may think that there is a high probability of success of the intervention. The declining yield may be due to increased soil acidity (low p^H). Then it is decided to test the use of lime to raize p^H. The team expects that lime will raise p^H, which should improve maize yield.

The team is not certain that the intervention will be acceptable to farm household members. FSR & D assesses is not just the biological response that is increased yield, but more fundamentally, the response of farm households to the use of the intervention.

In a trial, the acceptability of intervention (new practice or intervention) is non yet proven. The purpose of the trial is to see if it will be proven. In a demonstration, we say the practice is proven.

In a demonstration, we say, a larg difference we can expect. In a trial, in contrast, we say we don't know, and we are going to look first at the results assuming there is no difference.

Since this hypothesis is one of no difference, in statistics we call this the null hypothesis. The word "null" simply means "none" the assumed difference is none. One step in a scientific method is testing our results by others, to build consensus among everyone.

1. TYPE OF T-TESTS

T-tests are used to determine if a qualitative effect of 2 treatment is real. There are 2 types of t-tests :

1) Paired t-tests;

2) Unpaired t-tests.

1. Paired t-tests

In validation testing, usually only 2 treatment are compared; the farmer control and the intervention. The 2 treatments are present on every farm. This is a situation where a paired t-test is appropriate.

In livestock on-farm trials, each farm often only has a few animals. Each animal represents a large investment of money for the farm household. The animals frequently have important social value as well. Hence, the risk to the farm household of a treatment harming and animal is great. Farm these reasons, livestock on-farm trials may often only be able to use 1 animal per farm.

When only 1 animal per farm is available; for trials with adult animals, it may be useful to compare performance before and after the treatment. For example, milk production might be measured for a month for 1 animal on each farm before introducing a new feed ration. Milk production would then be measured for another month while the new feed ration was given. This is another situation where a paired t-test can be used. The paired t-test compares before an after values of the same treatment applied to the same experimental units (the same animals).

Of course, this comparison will not be valid if there are other major differences between the 2 months besides the change in feeding rations. For example, if the first month is the end of the hot, dry season, the animals may be stressed by heat and inadequate water. It the second month is the start of the rainy season, temperatures during the day will not be so high , due to cloud cover. Water will become freely available. The animals may appear to do better, but the main reason may be reduced stress due to the change in seasons, rather than the change in rations.

2) **Unpaired t-tests**

Another livestock trial might compare the 2 feeding rations at the same time. Farms with only 1 animal might be divided into 2 groups. The animals on farms in the first group would be given the new ration. The animals on farms in the second group would be given the farmer control ration. While the 2 groups would be chosen so that farms in both groups were more or less similar, it might not be possible to pair all the farms in each group one-by-one. The would be a situation where an unpaired t-test would be appropriate.

Sometimes a team may identify independent farmer experimentation. For example, 5 farms may be growing only the standard variety of sweet potato, but 5 farms growing a new variety, and 8 farms growing both. The team might take yield samples from plots on all 18 farms.

The 2 varieties could be compared for farms 11 through 18 with a paired t-test. However, perhaps the team considers all 18 farms to be from the same domain. The team thus may want to compare the data for the 2 varieties from all the 18 farms. This is another situation where an unpaired t-test would be appropriate.

Thus, in both of the above example, the unpaired t-test allows us to compare 2 treatments, where the 2 treatments are not always present on each farm.

Disadvantages of t-test/ANOVA procedures versus MSA for data from regional trials.

T-test/ANOVA	MSA
1. Cannot identify treatment-by-environment interactions when treatments are replicated only across farms, but not within farms.	1. Tests of hypotheses may not be valid.
2. Requires sophisticated understanding of principles and procedures of hypothesis testing and statistical inference based on probabilities.	2. Environmental index used as independent variable for regression is highly correlated with the dependent variables.
3. May be difficult to interpret more complex treatment structures.	3. May not be possible to use if the regression of 1 or more treatments on the environmental index is not significant.
4. May not be possible to use sites are too heterogeneous.	4. Understanding how the regression procedure works is easier if comparison is made with ANOVA.
5. Requires a long series of calculations even for simple designs.	5. Sums of products calculation is tedious, errors are easy to make, and there is no way to cross-check using intermediate sums.
6. Requires several long series of calculations with intermediate decision-points for more complex designs.	6. Most scientific calculators do not have statistical function keys for sums of products or regression.
7. Many scientific calculators do not have statistical function keys for simultaneous entry of data from RCBD.	
8. Incomplete block designs are more easily analyzed by computer, which is too sophisticated and inaccessible for most field teams.	

Disadvantages of t-test/ANOVA procedures versus MSA for data from regional trials.

	T-test/ANOVA		MSA
1.	Provides rigorous, valid tests of hypotheses.	1.	Can identify treatment-by environment interactions even when treatment means are equal.
2.	Provides a range of probabilities of making wrong decisions about comparisons among treatments.	2.	Can identify treatment-by environment interactions even when treatments are replicated only across farms, but not within farms.
3.	Can analyze many types of treatments structures.	3.	Can be used regardless of the degree of heterogeneity among sites.
4.	Can identify treatment by environment interactions when interactions are also replicated within farms.	4.	Promotes thorough investigation into differences among farms in a domain.
5.	Promotes disciplined, scientific thinking about hypotheses and statistical inference from a sample to a domain.	5.	Promotes thinking ahead to linkage with extension and dissemination of results to different types of farms.
6.	Can make use of statistical functions keys for sums of squares found on most scientific calculators.	6.	Can be combined with confidence intervals to provide a range of probabilities of making wrong decisions about comparisons among treatments.
7.	Cross-checking for treatments and blocks can be done easily on scientific calculators by comparing results obtained by line-by-line data entry and statistical keys versus results obtained by formulas using intermediate sums.	7.	Can be used for simple interpretation without understanding how the procedure works.
		8.	Is fairly easy to calculate by hand.

MONITORING

* Monitoring is the periodic review of activity status to fore cast achievement of events.

EVALUATION

* Evaluation is a process for determining systematically and objectively the relevance, efficiency, effectiveness and impact of activities in the light of their objectives.
* Evaluation is a process of thinking and a way of arriving at conclusions of the basis of certain pre-determined objectives.
* Evaluation is a process for improving activities still in progress and for aiding management in future planning, programming and decision making.

Types of Evaluation

1. On-going evaluation/build in evaluation
2. Special evaluation
3. Terminal evaluation
4. Ex-post evaluation
5. Impact evaluation

Monitoring	Evaluation
1. Accepts design as given	1. Challenge design
2. Measure progress	2. Draw conclusion and make judgments.
3. Focuses on compliance	3. Focuses on relevance.

Objective

1. Objective should be stated as completed actions.
2. Select strong action verbs or act. Such as build, install, eradicate, make, conduct, construct, reduce from x to y, increase from x to y.
3. Avoid using weak act such as coordinate, participate, assist, support, improve, integrate, collaborate, enhance, organize, advice, advocate.

INDIVIDUAL CROP DATA

A. GENERAL INFORMATION

1. Site ________________ 2. Season ______________ 3. Crop ________

2. Land type ________________________________

3. Cropping pattern ____________ ____________ ________ ________

   Crop-1 Crop-2 Crop-3 Crop-4

B. TECHNOLOGY FOR THIS CROP

1. Variety ____________________ 2. Seed rate (kgs/ha) _______________

3. Planting method ____________ 4. Plant spacing ____________________

   (rows x plant)

5. Plants/hill _________________ 6. Total N _____ P_2O_5 ___ K_2O ____

7. Basal N _____ P_2O_5 ___ K_2O ____

B.1 Seasonal standards (cost per kg.)

1. Cost/kg inputs

   ________ ________ ____________ ___________ _______

   Urea TSP MP S Zn

   _____________________ ____________________ ___________________

   Farmers' seed Improved seed Insecticides

2. Output prices

   ___________________ ____________________________ ______________

   Product (grains etc.) by product (straw, stick etc.)

   Others : ____________________ ________________ ________________

3. Labor wages (Tk/day) ____

4. Animal rental cost (Tk/day) _______________________________________

5. Estimated standard labour (Mandays) required for this crop ___ Mandays

6. Estimated standard animaldays required for this crop _________ Days.

C. **Data for each field :**

AGRO-ECONOMIC	Location 1	Location 2	Location 3	Location 4	Location 5	Range	Average
1. Farmers name							
2. Plot area (sq.m)							
3. Data of planting (seeding)							
4. Data of transplanting							
5. Age of seedlings							
6. Data of basal ferti-lizer application							
7. Date of first top dress							
8. Amount of N first top tress							
9. Date of second top dress							
10. Amount of N second top dress							
11. Number of irrigation and method							
12. Number of weeding							
13. Harvesting date							
14. Sampling area (sq.m)							
15. Sample fresh weight (kgs)							
16. Sample moisture content							
17. Field (kgs/ha) at--MC							
18. Field by product (kgs/ha)							
19. Kg. of product/ha/dab							
20. Value of grain (Tk/ha)							

(Table C Contd.)

AGRO-ECONOMIC	Location 1	Location 2	Location 3	Location 4	Location 5	Range	Average
21. Value of byproduct (Tk/ha)							
22. Gross benefit (Tk/ha)							
23. Total variable cost (TVC)							
a) Hired labor							
b) Family labor							
c) Hired animal power							
d) Owned animal power							
e) Fertilizer							
f) Seed							
g) Other							
24. Total cash cost-TCC (except 23 b+d)							
25. Gross margin (22-23)							
26. Cash gross margin (22-24)							
27. Gross benefit/TCC (22-24)							
28. Gross benefit/TVC (22-24)							

D. **Component Technology Studies**

1. Type of study ____________________						
2. Treatments T1 ________ T2 ________ T3 ________ T4 ________ T5 ________						
3. Plot area						
4. Sample area		Location - 1	Location - 2	Location - 3	Location - 4	Location-5
5. Sample fresh weight (kg)	T1					
	T2					
	T3					
	T4					
	T5					
6. Sample moisture content	T1					
	T2					
	T3					
	T4					
	T5					
7. Yield (kg/ha) at-X	T1					
	T2					
	T3					
	T4					
	T5					

K. Statistical Analysis of Component Technology Studies

Test of Significance

ANOVA	D.FC	S. S.	M. S.	F. C.	F. C.	Average
Treatments						T1
Replication ( )						T2
Error						T3
Total						T4
						T5

7. Information from crop cuttings and farmers' practices

Crop ______________________ Variety ______________________

Locat-ion	Plot area m^2	Seed rate kg/plot	10 m^2 sample fresh weight	Moisture %	10 m^2 yield	Urea	Fertilizer kg. Pesticide kg/ha labor per plot								
							TSP	TSP	Others	Cost Tk.	P. & Kg	C. Tk	Hu FH	Ani-mal FH	Tk.
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															

G. **Agronomic and economic performance of cropping patterns under farmers' management.**

Cropping pattern ________ ________ ________
Crop-1 Crop-2 Crop-3

Crop this season ____________________

Item	Location 1	Location 2	Location 3
1. Crop yield (tons/ha)			
2. Value of grain (Tk.)			
3. Value of byproduct (Tk.)			
4. Gross benefit			
5. Total variable costs (TVC)			
a) Hired labor			
b) Family labor			
c) Hired animal power			
d) Owned animal power			
e) Fertilizer			
f) Seed			
g) Insecticides			
h) Others			
6. Total cash cost-TCC			
7. Gross margin (4-5)			
8. Cash gross margin (4-6)			
9. Gross benefit/TCC (4-6)			
10. Gross benefit/TVC (4-5)			

H. Seasonal Report - Weather Summary

Site ____________________ Year _________________________

Data collection from (source) __________________________

Weekly rainfall and average maximum and minimum temperature.

Date	Rainfall (mm)	Temperature CC	
		Maximum	Minimum
1st week ( )			
2nd week			
3rd week			
4th week			
5th week			
6th week			
7th week			
8th week			
9th week			
10th week			
11th week			
12th week			
13th week			
14th week			
15th week			
16th week			
17th week			
18th week			
19th week			
20th week			

I. **Cropping Pattern Summary**

____________ ____________ ____________

Site Year Land type

Cropping pattern ____________________________

Item	Crop		
1. Crop name			
2. Variety			
3. No. replications			
4. No. failures			
5. Yield (ton/ha) Tk/ha			
6. By-product (t/ha)			
7. Gross benefit (G.B.) Tk/ha			
8. Hired labor cost (Tk/ha)			
9. Family labor cost (Tk/ha)			
10. Hired animal cost (Tk/ha)			
11. Own animal power cost (Tk/ha)			
12. Seed			
13. Fertilizer			
14. Insecticide			
15. Irrigation			
16. Others			
17. Total cash cost (Tk/ha)			
18. Total variable cost (Tk/ha)			
19. Gross margin (Tk/ha)			
20. Gross benefit (Tk/ha)			
21. TCC Tk/ha			
22. GB/Standard hired labor			
23. GR field days			
24. GB/marginal costs			

J - OPERATIONS

DATE	OPERATIONS PERFORMED	JABOUR (HOURS) MAN		WOMSR		SHILD		TOTAL COST OF LABOR (TK)		ANIMAL POWER NUMBER				TOTAL COST (TAKA)
		F*	H*	F*	H*	F*	H*	F*	H*	O	R	HOURS	COST	
	L_1													
	L_2													
	L_3													
	L_4													
	L_5													
	L_1													
	L_2													
	L_3													
	L_4													
	L_5													
	L_1													
	L_2													
	L_3													
	L_4													
	L_5													

Contd ..... J. Operations

	L_1													
	L_2													
	L_3													
	L_4													
	L_5													
	L_1													
	L_2													
	L_3													
	L_4													
	L_5													

* F = Family
* H = Hired

* O = Own
* R = Rent

MONITORING SHEET OF TEMPERATURE AND RAINFALL

FSR SITE ______________

MONTH ______________ YEAR ____________

FIRST FORTHIGHT

DATE	DAYS	TEMP. AT 6 A. M.		TEMP. AT 12 NOON		RAINFALL (mm)
		MIN.	MAX.	MIN.	MAX.	
1						
2						
3						
4						
5						
6						
7						
Weekly total						
Mean						
SD						
8						
9						
10						
11						
12						
13						
14						

DATE	DAYS	TEMP. AT 6 A. H.		TEMP. AT 12 NOON		RAINFALL (mm)
		MIN.	MAX.	MIN.	MAX.	
Weekly total						
Mean						
SD						
Fortnight total						
Mean						
SD						

PROCESS FOR INTEGRATING AND GUIDING FARMING SYSTEMS RESEARCH

Jerry L. McIntosh

Introduction

After selection, the target area for farming systems research should be delineated and described. The description should be as simple as possible but yet definitive for the purpose intended. Rather than to simply say 'we are going to characterize the soil' climate and socio-economic environment', it would be better to develop a check list and decide what background information is needed. As much as possible existing information should be used for site description and the other phases of the farming systems researchers must know where they are, what they are doing, and what is to be accomplished.

Check List of Systems Research in a Target Area

The attached generalized "Check List" has been developed to help on site FSR project leaders and their staff to more critically assess the progress of their research. For example, it may be concluded that descriptive data is available for phase-I (site Description). But the information must be collected and put into a usable form before we can decide if it is adequate.

The check list approach may also help program leaders to systematical appraise the progress of the research and make specific statements of commendation, criticism or advice kin line with the researchers objectives and goals. Unintentionally, many times, general statements are made in research reviews that are confusing to researchers.

Sometimes on site project leaders wither do not take the time or do not appreciate the necessity of explaining to their staff and guests the research approach and status of the research. Even though systems research in target area is not necessarily complex, it may be difficult to get an accurate perception of the research progress by looking at some of the parts (or components). A check list can help all concerned to more effectively assess research progress, unterstand the holistic nature of the research and communicate constructively.

CHECK LIST

PHASE* ACTIVITY **STATUS OF ACTIVITY**

I. Description of Target Area
(Data available in usable form)

	Inadequate**	Functional	Adequate
A. Physical			
1. Soil			
2. Water regimes			
3. Natural resources			
B. Climatic			
C. Biological			
D. Socio-economic			

II. Component, biological and economic potential studies
(available technology)

	Inadequate**	Functional	Adequate
A. Food			
B. In dustrial Cash crops			
C. Livestock			
D. Markets (for A,B and C)			
C. Water Management			

* phases may overlap; for example, Phase-II may be start before phase-I is "Adequate"

** Ratings in these phases refer to extent to which the activity has been executed by the FSR group. For example, "functioning" means enough information is available in usable form to proceed.

III. <u>Farm Systems Studies</u>
<u>(Evaluation or testing of :)</u>

STATUS OF ACTIVITY

	Inadequate**	Functional	Adequate
A. Existing System			
1. Subsistence			
2. Cash income (amount)			
3. Available family labor (no)			
4. Stability of production			
5. Sustainability of systems			
6. Premier commodities (list)			
7. Post production value added opportunities (what)			

** Ratings in these systems may refer to "robustness" of the activity being considered as well as to the extent of execution.

STATUS OF ACTIVITY

	Inadequate**	Functional	Adequate
A. Model Farm System			
1. Design			
2. Ex-ante analysis			
a. Subsistence			
b. Cash income			
c. Investment capital			
d. Available labor			
3. Test			
4. Rationalized production stability			
5. Rationalized system sustainability			
6. Scenario for production of scale for premier crops			
7. Scenario for post production value added			

** Ratings in these systems may refer to "robustness" of the activity being considered as well as to the extent of execution.

CONCLUSIONS

1. Component research for varietal improvement, crop management, as well as a better general understanding of other on farm agricultural enterprises, all indicate the need to study the whole farm system in some strategic locations.

2. A check list to guide, monitor, and evaluate progress of Farming Systems Research can be very useful to researchers, project leaders and administrators as the research takes place.

3. The tendency for the research to degenerate into more component studies should be avoided. An ex-ante analysis approach should be used as much as possible to minimize costs and time constraints in this kind of research. But finally the researchers must test their ideas in the field and carefully evaluate and re-evaluate.

4. We should not be discourage if the results show in some instances that particular agricultural enterprises, such as food crops production, should not be intensified. Hopefully, there will be viable options.

5. Researchers must provide the data base and technology alternatives to policy makers so that national policies and implementation strategies can be undertaken.

STATUS OF ACTIVITY

A. System for Introduction	Inadequate**	Functional	Adequate
1. Design			
2. Ex-ante analysis			
a. Subsistence			
b. Cash income			
c. Investment capital			
b. Available labor			
3. Test			
4. Rationalized production stability			
5. Rationalized system sustainability			
6. Scenario for production of scale for premier crops			
7. Scenario for post production value added			

IV. Technology Transfer

a) As much as possible technology transfer within a Target Area should take place through usual government channels.

b) Technology should be transferred to other areas with similar site descriptions. Successful transfer depends or adequate analysis, interpretation and publication of results.

** Ratings in these systems may refer to "robustness" of the activity being considered as well as to the extent of execution.

MODEL PREPARATION FOR-WHOLE FARM SYSTEMS

R. N. Mallick

A model is a means of describing and summarizing a system and its known properties. It helps to understanding what study is going on and where are gaps in knowledge. There are tow types of model.

1. Structual Model

Structual model focuses on the levels of interaction and integration among the various crops, livestock, and off-farm enterprises of a farm family. It is important for orienting and guiding the work of an interdisciplinary team. Understanding the whole context within which new technologies as to be promoted will help the team evaluate the potential of the proposed technology.

2. Process Model

The process model is used to develop an understanding of farmer management strategies, that is, the way farmers go about managing their farms. The model focuses on four types of information :

a) Farmers' Objectives and Priorities

The first priority of farmers is often to assure a stable supply of preferred foods at all periods of the year. Other objectives and priorities are influenced by cash requirements and the levels of risk with which farmers are willing to live. These will affect the tradeoffs farmers make in their investments; whether they will invest in production or spend for home consumption; whether they will invest in farm or non-farm enterprises; and how they will allocate their resources among their enterprises.

b) Environment (natural and socio-economic)

How does the environment influence the manner in which a farmer manages his/her farm ? Such physical factors as soil, rainfall, and altitude must be considered. The socio-economic environment in which the farmer works includes such factors as land tenure, household composition and labor patterns by sex, markets, and access to inputs and credit. Farmers are affected by institutions outside their control such as rural development organizations and government agencies which establish agricultural policies.

c) **Resource Availability and Use**

Land, labor, capital, and management practices are used by farmers to attain their goals and objectives. What types of land are available of labor ? What is the composition of the labor force ? Do farmers have access to cash when needed, access to machinery or draft power, access to other inputs such as seeds and chemicals ?

d) **Principal Constraints**

It is important to identify the constraints which farmers face. Constraints may be linked to resource availability such as peak season labor requirements, or cash for purchasing inputs. They may be linked to environmental factors such as soil fertility, rainfall distribution and variation, lack of markets, and land tenure issues.

The researcher uses this information to develop an understanding of farmer management strategies. That is, to understand how farmers use their resources to meet their objectives in the environment in which they live and given and constraints with which they are faced. These strategies include selection of enterprises and the relative importance of each in the system and cultural practices used. Often these reflect the ways farmers minimize risk.

Why is it important for us to understand farmer management practices ? Farmers possess a great amount of knowledge about their own environment and enterprises. It is important that the stock of indigenous knowledge, as well as that of modern science, be brought to bear on any given problem. In most instances farmers recognize their problems and have ways, which vary in effectiveness, for dealing with these problems. Our objective is to work together with them to improve their ability to deal with their problems. Tapping their knowledge will help researchers identify evaluation criteria for screening technologies which are acceptable to farmers. Understanding the current situation is necessary before we can determine how to modify it.

WHOLE FARM CONCEPT

To study the interaction and interdependence of the various component research should be conducted with whole farm concept. After the diagnostic survey 6 representative farmers from major client group should be selected and research on each component should be conducted. Most of the agro-ecological aspect of the research can be done with these farmers. Some specific component technology may be done with other farmers which do not need strict system approach.

Generally land under cultivation is divided into several parcels (plots). Only one or two of which are used for cropping pattern testing. All the parcels belonging to selected farmers should be used for testing different cropping to selected to seed if the farmers' resource endowments allow them to follow the alternatives. The farmers' homestead, livestock, poultry, fish-cup-duck culture and on-farm agro-forestry will also be taken into consideration depending upon the need and availability of technology.

To understand whole farm concept a typical example of a farm family is given below with possible type of research to be conducted. This may be replicated in 6 farms.

Research plan should be developed on the basis of problems identified. Some typical research plans which are used by FSR, Kalikapur and BAU are discussed to understanding clearly.

After identification of problem the objective of research should be defined, then suggested activities can be proposed for discussion among scientists and farmers. After final discussion research should be carried out. Some research may be done with whole farm concept which will be as systems research. Certain aspect shall need to have some study to fit into systems. Those should be studied across farm in suitable land type.

A typical small farmer having about one hectare of land may have 10 parcels in different land categories. Some of them have irrigation. His family size may be seven. He is mainly dependent on agriculture for livelihood. He has highland and medium highland, some homestead area, 5-6 poultry birds, 2 cows for dwelt purpose, goats and other resources. A tentative brief research plan for him may be as follows. This may be modified at different locations.

1. <u>Cropping Pattern Testing</u>

1.0	Highland rainfed
1.1	(Farmers-F) Broadcast Aus Rice - Mustard + Lentil
1.1.1	(Improved-I) Broadcast Aus Rice - Mustard (MV) + Lentil
1.1.2.1	Maize + Mungbean - wheat
1.2	Medium highland - rainfed
1.2.1 (F)	B.Aus - T.Aman - Fallow
1.2.2.I	B.Aus - T.Aman (MV) - chickpea (MV)
1.3.1	Medium highland -irrigated
1.3.IF	Jute - T.Aman - Wheat
I	Mungbean - T.Aman - Maize
I	Mungbean - T.Aman - Wheat

1.3.2F	T.Aman - Boro
I	Maize - T.Aman (MV)/Mustard (MV) - Boro
1.3.3F	T.Aus - T.Aman - Potato
I	Maize - T.Aman (MV) - Potatoes

2.0 Homestead Program Pattern Study

2.1.F	Local varieties of some winter and summer vegetable
2.1.1.I	Red Amaranthus-Red Amaranthus-Indian Spinach-Spinach-Tomato
2.1.2.I	Okra-Cancan-Eggplant-Red Amaranthus
2.1.3.I	Amaranthus-B.Chinensis-B.Chinensis-Radish-Garlic
2.1.4.I	B.Chinensis-Red Amaranthus-Radish-Bittergourd
2.1.5.I	Red Amaranthus-Eggplant-Red Amaranthus-Cattage

3.0 Homestead Program - Fruits

3.1.F Various plants not definite

3.1 Papaya - 12 plants
Cooking banana-5 plants
Guava 3 to 5 plants
Seedless lemon and others according to need & space.

4.0 Homestead Program - Fodder cum fuel Plants

Epil-Epil around boundary of homestead.
Encluptces - 5 to 15 plants

5.0 Agro-Forestry

5.1 Acasia tree in Bangladesh
5.2 Dhaincha on bunds
5.3 Country bean on bunds

Homestead Production Systems

The homestead of a farmer in Bangladesh is a multipurpose production and utilization centre. Approximately 70% of wood and 90% of fuel wood and bamboo come from rural homesteads. Cattle, poultry, goats, a few plants of different cucurbits, other vegetables, trees for multiple use are raised in different combination on and around the homestead. These production activities are almost exclusively looked after by the womenfolk but have tremendous impact on family income and expenditure. These aspects should be carefully studied to seed interaction with other components of FSR. alternatives should be tested putting emphasis on family nutrition small cash earning throughout the year family fuel needs and employment of the women labour force at the family level.

Objectives of Homestead may be some of these

1. To utilize homestead area profitably by growing vegetables quick growing fruits and firewood plants.

2. To employ the women labour.

3. To findout suitable sequences of vegetable crops which can be grown throughout the year.

4. To evaluate the utilization pattern of homestead crops by different farmers.

5. To get the farmers reaction about new vegetables and fruit crops.

6. To study the interaction of homestead with other components of farming systems.

An example of homegardening is illustrated as follows (FSR - Kalikapur) :

Problems

Low income group of farmers are seriously suffering from malnutrition. The homestead area remains fallow or under utilized in most of the time of year.

Objective

To develop technology for efficient and profitable utilization of homestead area.

Activity

a) Suitable sequence of vegetable and species crops are to be findout which can be grown throughout the year.

b) Selection of quick growing fruit trees and development of component technology for them.

1.	Proposed pattern	Lalsak	Lalsak	Indian Spinach	Spinach	Tomato
	Variety	Local (Altapati)	Local (altapati)	Local	Local	World Champion
	Planting date	15 Feb.	1 April	15 May	1 Sept.	5 Nov.
	Seed rate (kg/ha)	1.5	1.5		30	0.150
	Spacing	Broadcast	Broadcast	50 x 10 cm	20x5 cm	50x75 cm
	Fertilizer ($N-P_2O_5K_2O$ kg/ha)	60-30-60	60-30-60	90-45-60	90-45-60	150-120-100
	Cowdung/ha	10	10	15	10	15
	Seedling age (days)					30 x 35

2.	Proposed pattern	Okra	Gima Kalmi	Brinjal	Lalsak	
	Variety	Local	-	Uttara	Local	
	Planting date	1 April	16 May	1 September	1 Feb.	
	Seed rate (kg/ha)	5	12	0.200	1.5	
	Spacing	50x45 cm	25x15 cm	50x75 cm	Broadcast	
	Fertilizer ($N-P_2O_5K_2O$ kg/ha)	100-80-90	100-50-20	150-60-100	60-30-60	
	Cowdung	15	40	15	10	
	Seedling age (days)			35 - 40		

3.	Proposed pattern	Data	China Sak	China Sak	Radish	Garlic
	Variety	Katwa			Tasakisan	Local
	Planing date	15 March	15 May	15 July	1 October	1 Dec.
	Seed rate (kg/ha)	1.5	1.0	1.0	10	400

Spacing	20x5 cm	60x20 cm	60x20 cm	35x5	10x15
Fertilizer (N-$P_2O_5K_2O$ kg/ha)	80-45-90	175-110-135	175-110-135	300-175-175	70-80-150-10
Cowdung	15	5	5	3	10
Seedling age (days)					
4. Proposed pattern	Batisak	Lalsak	Radish	Bittergourd	
Planting date	1 June	1 August	1 October	1 December	
Seed rate (kg/ha)	1.0	1.5	10	6	
Spacing	25 x 60	Broadcast	25x5	150x50x30 cm	
Fertilizer (N-$P_2O_5K_2O$ kg/ha)	175-100-135	60-30-60	300-175-175		
Cowdung (t/ha)	5	10	3	3	
Seedling age (days)					
5. Proposed pattern	Lalsak	Brinjal	Lalsak	Cabbage	
Variety	Local	Uttara	Local	Atlas-70	
Planting date	15 Feb.	1 April	1 September	15 Oct.	
Seed rate (N-$P_2O_5K_2O$ kg/ha)	60-30-60	150-6-100	60-30-60	150-50-40	
Cowdung	10	15	15	25	
Seedling age (days)	35-40	-	-	30-35	

QUICK GROWING FRUITS

SL No.	Name of Fruit	Number/ Family	Fertilizers (kg/pit				Urea Press kg/plant
			Cowdung	Urea	TSP	MP	
01.	Papaya	12	10	-	0.45	0.25	1 + 1
02.	Cocking banana	5	-	-	0.5	0.08	0.06+0.02
03.	Guava	5	-	0.30	0.50	0.25	-
04.	Seedling Lemon	2	-	0.60	0.70	1.00	-

AGRO-FORESTRY COMPONENT

Forestry occupy about 8% of the land area and forest products make up about 5% of the total value of all agricultural products. Approximately 70% of wood and 90% of fuel wood and bamboo come from rural homestead. Agro-forestry can be developed from two directions :

1. Introducing inter-cropping in designated forest areas.

2. Introducing woody perennials into the existing farming systems site.

   a) Village tree cultivation

The following studies on agro-forestry may be included in farming systems research :

i) Benchmark survey on homestead production by homestead size and income groups.

ii) Sociological research to determine farmer and local community perception of the usefulness of trees, their views on such critical matters as choice of species and their willingness to co-operate with Government in management and protection of forest.

iii) Identification of high yielding and fast growing fuel wood species and other multiple use crop for on-farm trials.

iv) Identification of light-demanding and shade-tolerant agricultural, horticultural, forage and medicinal plants for intercropping with tree species in planting both on government forest land and on marginal and waste land.

v) Research on the development of multistoried forest with multiple use species for timber fuel, fodder, food and medicinal plants.

vi) Development of techniques for maximizing sustainable production of tree fodder and fuel wood using such techniques as branchwood, lopping, pollarding, copping and hedgerow management.

vii) Studies on agricultural, horticultural and forest trees crop mixtures.

Some of the research area in FSR site illustrated as follows:

(2) <u>Problem</u>

Acasia plants are grown in highland of Sara and Gopalpur Soil Series in a upland manner. Information is not available about the effect of this tree plant in soil and crop growth.

<u>Objective</u>

To know the effect of growing acasia and other tree plants on crop growth and soil properties and to develop technology for crop-tree association.

<u>Activity</u>

a) Effect of tree plants on soil properties and crop growth is to be findout.

b) Development of component technology for crop-tree plant association.

c) Selection of crop and tree species suitable for crop-tree association.

(3) <u>Problem</u>

Medium lowland remain fallow after rice harvest under rainfed condition.

<u>Objective</u>

To utilize alleys of medium lowland for producing vegetables or fuels.

Activity

a) To grow countrybean as grown in Chittagong region. To plant countrybean seeds in July - August and put wooden support for vines. Beans are available from October till May.

To seed Dhaincha (Sessabenia acculeata) on ails after rice planting and harvest when plant matures.

Seed Pigeonpea (Cajanus Cajan) on high bunds after rice harvest.

(4) Problem

Homestead has some slow growing fuel cum fodder plants which are not so productive.

Objective

To utilize border of homestead area most efficiently for fuel cum fodder.

Activity

a) To seed Hawaian variety of gaint epil-epil in March - April after first rainfall protect the plant for 3 month from grazing.

It may be transplanted in June - July when seedlings are available.

(5) Problem

Fuel is a serious problem in rural farm families and more acute with marginal, small and landless farmers of the project area.

Objective

To develop technology for minimizing fuel problem of landless, marginal and small farmers.

Activity

a) Selection of quick growing fire-wood trees to be planted in homestead.

b) Development of suitable cropping pattern.

i) Jute	-	Mustard		
ii) Jute	-	M. Bean	-	Sunflower
iii) M. Bean	-	B.Aus rice (L)	-	Pigeonpea
iv) B.Aus Rice+Dhaincha			-	Sunflower
v) Jute	-	M. Bean	-	Maize
vi) Maize	+	M. Bean	-	Wheat

c) Development of component technology for firewood plants and fuel supplying crops.

d) Adaptability of Sunflower

e) Compare efficiency of burner/hearth developed by different organizations at farm level.

f) Suitable storing method is to be developed for fuel supplying materials.

LIVESTOCK COMPONENT

Cows, bullocks and waterbuffalo are next to crops in importance. Livestock contributes 6.5% of gross domestic product whereas crops contribute 36.8%. effect of alternative cropping systems technologies on large animals will be estimated. Flow change in cropping systems influences animals numbers, draft power, yield of animal by-products and type of animals chosen.

During Monitoring and survey following may be considered :

1. Initial inventory of all animals by species, sex, age (by teething and owner estimate) weight (by spring scale or tape), height, flesh condition, health, reproductive stage, reproduction history (as possible), survival record of previous offspring, lactation stage, draft load in type and days (hrs) and length of lactation.

2. Collect milk yield, egg production, chick production, young animal gains, animal product sales, consumption and price.

3. Quantity of fodder and feed both from home production and purchase with price for each type and source of feed.

4. Labour used for feeding, watering, grazing, working, etc.

5. Record hours and days of work in owners, fields and for rental (cultivation, threshing and transport).

6. Prices of all inputs and outputs.

7. Repeat inventory with weight and height measurements quarterly.

8. Repeat collection of yield gains, sale and consumption monthly.

9. Record health treatment data.

10. Record death and mortality dates and causes as best known.

11. Record amount of waste or loss from storage and feeding or treated and untreated straw.

12. Measure length, weight and number of fish from manure-fed versus non manure-fed ponds.

<u>SUGGESTED RESEARCH PRIORITIES</u>

1. Straw treatment with urea in baskets, plastic bags and or stocks to test both value for storage and value as measured by performance of animals consuming the feed.

2. Relay legume or maize crop to minimize tillage for food grain and for storage to be directly or after storage.

3. Use cows for draft with seasonal breeding to avoid season of heavy work during late pregnancy and lactation.

4. Fallow recommended vaccination schedule and internal parasite treatment for cattle, buffalo, goats, sheeps and or poultry.

5. <u>Poultry Component</u>

Traditionally, poultry is reared by almost all the rural families and landless farmers in particular. It plays an important role in the upliftment of socio-economic condition and the effort to narrow the gap of animal protein requirement in human diet. The disease problem is one of the major constraints in the development and maintenance of poultry. The annual loss in poultry due to various diseases is enormous.

i) Improvement of indigenous birds by upgrading, organizing to set up small poultry units.

ii) Formation of poultry societies with interested poultry raisers.

iii) Motivation of rural people for improvement of nutritional status through consumption of increased quantity of eggs and meat.

iv) Self employment of youth through poultry raising.

Cockerel Exchange Program : Methodology.

Coloured breed cockerels FIR and Astralorp of 18-20 weeks of age should be supplied to the farmers mating with indigenous hens. For maintaining 50% exotic character with crossbred hen, brother sister mating will be continued. All the farmers should be advised to dispose their indigenous cocks before supplying the improved breed cockerels, when they will have.

Problem

Green fodder is not available during December-February and straw scarcity is observed in the month of May - June and October - November (FSR - Kalikapur).

Objective

To develop technology for improvement of fodder problem.

Activity

a) Selection of suitable fodder crop species.

b) Utilization of marginal land by growing suitable fodder crops.

c) Development of cropping pattern.

i) B.Aman/Khesari
ii) Maize-Fallow-Lentil+Mustard
iii) B.Aus+Shorgum+M.Bean-Maize.

FISHERY COMPONENTS IN FSR APPROACH

Ponds and haors contribute 3% of the water resources for inland fish production. The following research programme on farming systems is proposed :

1) Improvement of fish culture techniques in ponds.

2) Proper use of water for agriculture and aquaculture.

3) Integrating farming fisheries, horticulture and livestock.

4) Improvement of fish culture technique in paddy fields.

5) Use of the harvested rice field as a nursing ground for carp spawn.

EXAMPLE : FISHERIES COMPONENTS

Experiment cultivation of Nilotica in the lying ditches.

Objective

To study the profitability of fish cultivation in the small ditches in the winter.

Technology

Fish variety	:	Nilotica, Mrigal, Catla, Rui
Replication	:	6 farmers
Mini pone size	:	As available size
Manures and	:	Cowdung - 400 kg/ha
Fertilizers	:	Urea - 120 kg/ha
		Lime - 120 kg/ha

Fertilizer Application

1) Lime used after reconstruction before fri release

2) Cowdung 15 days after lime application.

3) 1/3 Urea & 1/2 TSP along with cowdung; rest quantity will be applied in installments as and when required.

Size of fingerlings	:	6 - 9 cm
No. of fingerlings	:	5000 fingerlings/ha
Releasing of fingerlings	:	October
Food Supply	:	1:1
Maintain water depth	:	Maintaining 1m water depth
Period of stocking	:	6 months (approx)
Observations	:	The following data should be recorded.

1) No. of fingerlings released
2) Size of fingerlings

3) Date and quantity of fertilizer application
4) Artificial food supplying and and quantity
5) Date, size, number and weight of fingerlings at harvest.

Experiment

Rice-cum-fish culture in the boro season.

Objective

To find out the possibility of cultivating fish in rice field in the boro season in deep water land.

Technology

Rice variety	:	Pajam, Tepi boro (local)
Fish variety	:	Nilotica, Rui, Mrigel
Replication	:	6 farmers
Age of rice seedlings	:	50 days
Spacing of rice	:	30 cm x 20 cm
Seedlings/hill	:	2-3 Nos
Transplanting rice	:	December
Size of fingerlings	:	8-10 cm
Releasing fingerlings	:	25 days after transplanting
Fertilizer does	:	$N-P_2O_5.K_2O$ at the rate of 120-80-40 kg/ha CaO @ 110 kg/ha if P^H below 6.

Fertilizer application

CaO, TSP and MP at the time of final land preparation. Urea in three equal splits at 20, 60 and 90 days after transplanting.

Experiment : Duck-cum-fish culture

Objectives

To compare the possible profitability of duck and fish culture single and combined in the mini pond.

Technology

Replication	:	6 farmers
Fish variety	:	Nilotica, Mrigel, Rui
Duck breed	:	Indian runner or khaki cambel
Water depth	:	Maintaining 1m water depth
Liming	:	Lime application as before if soil P^H below 6.
Manuring	:	Cowdung @ 2000 kg/ha. 5 days after liming
Fertilizer	:	Urea-60 kg/ha, TSP 60 kg/ha.

Fertilizer Application

As before

No. of ducks	:	600/ha
Age of ducks	:	3-4 months
Release of ducks	:	Late November
Feed of ducks	:	Mixture of the following :
		Broken paddy 50% oyster shell-1% Oilcake 30%, Fish meal - 8% Wheat bran 10%, Salt 1%
Size of fingerling	:	8-11 cm
No. of fingerling	:	5000/ha
Releasing fingerlings	:	Late November
Protection measure	:	Protect disease attach of duck when necessary.
Date collection	:	1) No. of eggs produced/bird /season
		2) Feed intake/daybird

3) Preventive measures taken by vaccine and medicine

4) Recording wt. and no of fishes and duck at harvest of fish.

Period of stocking : 6 months (approx)

Data Collection and Reporting

Whole research is based on precise data collection. Data for each component should be collected on proper Format. The format should be developed before initiation of research. The present monitoring forms for data management on Farming Systems Research sites for crop research should be used (Appendix-2). Similar format for other component of FSR should be subsequently.

Communications

The following communication will be considered to implement the FSR programme.

i) To establish an effective communications with farmers, the research plants must focus on farmer's needs and emphasis must be given to the study of those technologies that benefit all categories of farmers. Client groups for the different types of research be identified before the initiation of the field trials.

ii) To ensure an active participation of farmers, the different client groups should be involved from the very beginning of FSR programme in a site. This include the planning, execution and the evaluation stages.

iii) Communication at all stages of an FSR approach may be strengthened with the participation of the multidisciplinary groups, farmers and extension people. The team farmers-interdisciplinary group of researchers and extension people should participate in all stages.

iv) The communication between farmers and researchers must be done with in the weekly activity.

v) Training in FSR approach should be given jointly to all the team members who participate in the implementation of the programme.

vi) Objectives of the research programme must be clearly explain to the co-operator farmers.

3) Preventive measures taken by vaccine and medicine

4) Recording wt. and no of fishes and duck at harvest of fish.

Period of stocking : 6 months (approx)

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iv) The communication between farmers and researchers must be done with in the weekly activity.

v) Training in FSR approach should be given jointly to all the team members who participate in the implementation of the programme.

vi) Objectives of the research programme must be clearly explain to the co-operator farmers.